МЕТАЛЛУРГ

METALLURGIST

(METALLURG)

IN ENGLISH TRANSLATION

1957

NO. 6

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SIGNIFICANCE OF ABBREVIATIONS MOST FREQUENTLY ENCOUNTERED IN SOVIET PERIODICALS

FIAN	Phys. Inst. Acad. Sci. USSR.
GDI	Water Power Inst.
GITI	State Sci.-Tech. Press
GITTL	State Tech. and Theor. Lit. Press
GONTI	State United Sci.-Tech. Press
Gosenergoizdat	State Power Press
Goskhimizdat	State Chem. Press
GOST	All-Union State Standard
GTTI	State Tech. and Theor. Lit. Press
IL	Foreign Lit. Press
ISN (Izd. Sov. Nauk)	Soviet Science Press
Izd. AN SSSR	Acad. Sci. USSR Press
Izd. MGU	Moscow State Univ. Press
LEIIZhT	Leningrad Power Inst. of Railroad Engineering
LET	Leningrad Elec. Engr. School
LETI	Leningrad Electrotechnical Inst.
LETIIZhT	Leningrad Electrical Engineering Research Inst. of Railroad Engr.
Mashgiz	State Sci.-Tech. Press for Machine Construction Lit.
MEP	Ministry of Electrical Industry
MES	Ministry of Electrical Power Plants
MESEP	Ministry of Electrical Power Plants and the Electrical Industry
MGU	Moscow State Univ.
MKhTI	Moscow Inst. Chem. Tech.
MOPI	Moscow Regional Pedagogical Inst.
MSP	Ministry of Industrial Construction
NII ZVUKSZAPIOI	Scientific Research Inst. of Sound Recording
NIKFI	Sci. Inst. of Modern Motion Picture Photography
ONTI	United Sci.-Tech. Press
OTI	Division of Technical Information
OTN	Div. Tech. Sci.
Stroiizdat	Construction Press
TOE	Association of Power Engineers
TsKTI	Central Research Inst. for Boilers and Turbines
TsNIEL	Central Scientific Research Elec. Engr. Lab.
TsNIEL-MES	Central Scientific Research Elec. Engr. Lab.– Ministry of Electric Power Plants
TsVTI	Central Office of Economic Information
UF	Ural Branch
VIESKh	All-Union Inst. of Rural Elec. Power Stations
VNIIM	All-Union Scientific Research Inst. of Meteorology
VNIIZhDT	All-Union Scientific Research Inst. of Railroad Engineering
VTI	All-Union Thermotech. Inst.
VZEI	All-Union Power Correspondence Inst.

Note: Abbreviations not on this list and not explained in the translation have been transliterated, no further information about their significance being available to us. – Publisher.

NEW TECHNIQUES FOR METALLURGISTS

Only by raising the technical level of production will it be possible to ensure the unswerving development of ferrous metallurgy, increased output and quality of metal, reduction in its cost and improved working conditions. Steps for the development and introduction of new techniques should therefore always be the focus of attention of metallurgists.

Not a little has been done in the past year to introduce advanced technology in production. Blast furnaces received 37% more fluxed sinter than in the previous year. The starting up of new oxygen plants at the Petrovsk, Novo-Tagil and Makeevka works enabled the output of open-hearth steel using oxygen to be increased by one and a half times compared with 1955, and the smelting of converter steel to be organized at the Petrovsk works. Rolling mill workers adopted a number of new economic rolled sections. New technological processes were introduced into the iron and steel products industry, the by-product coke industry and other industries.

Many of the steps earmarked for 1956 for raising the technical level in the ferrous metals industry were not, however, put into practice. In the first place, this refers to work on the automation of furnaces and mills. At the "Azovstal" works, automation of the scale cars was not completed, and this has delayed the introduction of a system of complex automation of charging the blast furnaces; at the Voroshilov metallurgical works, automation of blooming mill 1150 was not completed, and at the Makeevka works, that of the strip mill. Tube rolling mill 400 at the Zakavkaz metallurgical works and mill 250 at the Bakin tube works were not converted to automatic operation.

This year, an extensive program is envisaged for ferrous metallurgy in the development and introduction of highly productive technological processes, further mechanization of labor-consuming and heavy work and the automation of industrial processes.

In the course of 1957, blast-furnace men should receive more than 43 million tons of fluxed sinter of high basicity. At 10 blast furnaces, complex automation of charging is contemplated: selection and weighing the charge and movement of scale cars will be effected automatically.

The steel melters are faced with serious problems. Putting into operation new oxygen plants at the "Zaporozhstal," "Azovstal," Petrovsk, Dzerzhinsk, Krivorog and Chelyabinsk metallurgical works will enable the production of steel to be considerably intensified. At four works, it is intended to organize the vacuum treatment of steel in the ladle and to cast it under vacuum. At the Stalin metallurgical works, preparations are in progress for the construction of a four-stream plant for the continuous casting of steel. A large amount of work is yet to be done in improving the automatic operation of open-hearth furnaces heated by a mixture of gases, either using oxygen and a carburizing agent or a carburizing agent alone.

In 1957, it is intended to adopt and organize on an industrial scale the centrifugal casting of hollow tubular articles from alloy and high-alloy steels, as well as the centrifugal casting of cast-iron pipes.

At the Krivorog and Bakin works, work is to be done in the automation of blooming mills and bar mills,

at the Novolipets and Novosibirsk works, that of the sheet-rolling mills.

Ten automatically controlled production lines are to be provided for the production of screws and eight for bolts.

To provide metallurgical works with new techniques scientists, planners and designers will have to carry out an extensive program of work covering scientific research, design, experiments and trials.

The Central Scientific Research Institute for Ferrous Metallurgy, together with the metallurgical works, must develop the technology of smelting pig iron with a blast furnace top gas pressure of up to 1.5 atm. gage. For this purpose, it is essential to study the technical and economical factors of blast furnace operation for different gas pressures. It is also necessary to develop and experiment with a system for the automatic control of the blast furnace melting process and the sintering process, to carry out further research on the technology of steel production by the direct reduction of iron from ore in the open-hearth furnace, on the complex automatic control of blooming mills using computer devices, and on other very important problems.

THE USE OF NATURAL GAS IN FERROUS METALLURGY

A. Ya. Lenkov

(Chief of Power Department of Ministry of Ferrous Metallurgy of U.S.S.R.)

The use of natural gas at ferrous metallurgical undertakings in the fifth five year plan was insignificant. Up to 1955, natural gas was supplied to the Saratov Iron and Steel Products Works (in quantities which did not fully cover the requirements for the furnaces), the Kiev Mechanical Works of Glavmashmet, small iron and steel undertakings in Moscow and the partly metallurgical works "Serp i Molot."

The total amount of natural gas used by ferrous metallurgical works in 1955 was 6 million m^3.

During 1955 and 1956, the metallurgical works "Krasny Oktyabr" converted 3 open-hearth furnaces and more than 50 heating furnaces to natural gas. Towards the end of 1956, the quantity of natural gas used at the works rose to 60 million m^3 per annum.

During 1956, the Andreev works at Taganrog made strenuous preparations for changing over to natural gas. This works is supplied with gas from the Stavropol area. In 1957, the Dnepropetrovsk group of metallurgical works will receive gas from the Shebelinka — Odessa gas main which will be extended to Dnepropetrovsk.

The requirements of natural gas by iron and steel undertakings according to the 1957 plan will be 405 million m^3 annually. Towards 1960, more than 20 iron and steel undertakings will be using natural gas with a total annual requirement of 2700 million m^3.

Works at present using fuel oil are going over to natural gas. Natural gas is also being supplied to the Magnitogorsk Metallurgical Combine and to the "Zaporozhstal" works, despite the fact that both these concerns have large local supplies of coke-oven and blast furnace gas.

In the blast furnace industry, the use of increased blast pressure, high blast temperature and fluxed sinter is considerably reducing the coke consumption. The calorific value of the blast furnace gas is diminishing at the same time. The figures of Table 1 indicate the drop in yield of blast furnace gas for the period 1952-1955 at the two works mentioned above.

Due to the lower yield of blast furnace gas, the total gas resources have been curtailed and there has been a considerable shortage of fuel, which at the Magnitogorsk Metallurgical Combine is at present being covered by the use of oil fuel.

As a result of the use of natural gas at metallurgical works in the sixth five-year plan, about 950,000

TABLE 1

Years	Yield of blast furnace gas			
	"Zaporozhstal" works		Magnitogorsk Metallurgical combine	
	m^3/ton iron	%	m^3/ton iron	%
1952	3630	100.0	2750	100.0
1953	3620	99.8	2610	94.8
1954	3610	99.4	2230	81.0
1955	3180	88.0	2010	73.2

tons of liquid fuel will be released for the requirements of the national economy, 450,000 tons of which will result from the conversion of open-hearth furnaces to gas heating.

Table 2 shows the sources of supply of natural gas and the undertakings which will be supplied by the end of the sixth five-year plan.

TABLE 2

Locality	Quantity of gas millions m^3/year	Consumers
Archedan and Saushin	385	Metallurgical works "Krasny Oktyabr," Stalingrad steel-wire cable works
Stavropol	415	Andreev metallurgical works, Sulin metallurgical works and the Yakubov Voroshilovgrad tube-rolling works
Karadag	125	Bakin tube-rolling works
From Moscow gas resources	184	Metallurgical works "Serp i Molot," iron and steel products works "Proletarsky Trud," Moscow tube works
Dashav	1	Kiev works of Glavmashmet
Saratov	5	Lenin iron and steel products hardware works at Saratov
Shimbaev (by product gas)	350	Magnitogorsk Metallurgical Combine
Shebelin	1230	Novomoskovsky tin- plateworks, iron and steel works in Dnepropetrovsk, Zaporozhye, Kharkov and the Dzerzhinsk works

BLAST FURNACE PRODUCTION

From the Data of the All-Union Conference of Blast-Furnace Men

OPERATION OF BLAST FURNACES ON OXYGEN-ENRICHED BLAST

F. A. Khilkevich, B. L. Lazarev and S. V. Bazilevich

Nizhne-Tagil Metallurgical Combine

In 1956-1957, workers at the Novo-Tagil metallurgical works carried out smelting experiments on the production of iron for steel manufacture and ferromanganese using oxygen-enriched blast.

Members of the Central Scientific Research Institute for Ferrous Metallurgy participated in the work of smelting iron for steel manufacture.

The blast was supplied with commercial oxygen (96-98% O_2), produced in the oxygen plant equipped with three units KT-3600; capacity of the plant is about 10,000 m^3 of oxygen per hour. The oxygen content of the blast was about 24%. The iron was smelted in a blast furnace having a volume of 1386 m^3 and the ferromanganese in a furnace having a volume of 1100 m^3. The coke for the burden was produced from Kuznetsk coal and had the following characteristics: mechanical strength (drum test) 320-340 kg, content of 0-10 mm fraction in the portion under the drum 31-43 kg, ash content 10.3-11.0%, sulfur content 0.4%.

Smelting Iron for Steel Manufacture

The burden for smelting pig iron for steel manufacture consisted of fluxed Vysokogor sinter with a basicity of 1.0, unfluxed Goroblagodat sinter and screened Goroblagodat and Lebizhinsk magnetic iron ores. Both sorts of sinter are made from magnetite concentrates and have low reducibility and mechanical strength, due to the relatively high coarseness of the concentrates (up to 13-15% of the 8-16 mm fraction). Table 1 gives data of the blast furnace burden and iron content.

Iron smelting with ores of the Tagil-Kuvshinsky region has a number of important features. Considering that the burden contains not very reducible ores and sinters, and a readily fusible gangue, coupled with the large amount of fines in the burden, the possibility of forcing the furnaces by increasing the volume of blast is limited. The working of the furnace is therefore forced by increasing the ore loads to 2.5-2.6 and the blast temperature to 850-900°C. In these circumstances, it is necessary to keep a careful watch on the distribution of the charge over the furnace cross section. The absolute humidity of the blast should not exceed 20 g/m^3. This enables maximum production to be achieved with minimum coke consumption. It is also necessary to have uniformity in the methods of regulating the furnace working and technical conditions by all three shift foremen.

During the trials, the oxygen was supplied to the suction chamber of the blowers. The oxygen content of the blast was increased gradually in three stages. In the first stage, the blast contained 22.0-22.5% oxygen. With this oxygen content, the furnace operated for six days, in the course of which the shift personnel worked out in detail the technical method of working with enriched blast. Simultaneously with the introduction of oxygen, the quantity of the blast was reduced so as to retain the previous quantity of gas formed in unit time and so as not to cause hanging of the charge. The reduction in the blast was on the average 0.8% for each percent increase of oxygen in the blast (within the range 21-24% O_2 in the blast). At the same time, it caused a reduction in the quantity of physical heat introduced into the hearth. In this connection, when the furnace was changed over to oxygen-enriched blast, the humidity of the blast was kept at the previous level (20 g/m^3), and its temperature was raised, but no higher than was required for regular descent of the charge.

TABLE 1

Material	Iron content	Proportion in Charge %	
		with normal blast	with enriched blast
Vysokogorsky sinter	51-53	70.8	70.0
Goroblagodatsk sinter	50-52	12.4	10.00
Goroblagodatsk magnetic iron ore	49-51	14.2	10.0
Lebyazhinsky magnetic iron ore	45-48	2.6	10.0

The oxygen content of the blast was then increased to 23.3% and further to 24.0%. Table 2 gives the results of operating blast furnace No. 4 on ordinary blast and on oxygen-enriched blast. The principal factors of the working conditions of the furnace for individual days are shown graphically in Figs. 1 and 2.

When using oxygen-enriched blast, the working of the blast furnace was smooth and steady. The charge descended regularly; consumption, pressure and temperature of the blast were constant and the yield of top dust and the ratio of CO to CO_2 content in the blast furnace gas were even less than when using ordinary blast. It was furthermore unnecessary to increase the humidity of the blast. When there was slight chilling of the furnace, the foremen usually reduced the humidity of the blast and raised its temperature.

TABLE 2

Working Data of Blast Furnace No. 4 at the Nizhne-Tagil Combine Using Ordinary Blast and Oxygen-Enriched Blast

Smelting factors	Working periods 1956			
	4/1 - 6/30	7/25 - 7/30	7/31-8/10 and 8/20-8/22	8/11 - 8/19 (excluding 8/16)
Duration of period, days	90	6	14	8
Oxygen content of blast, %	21	22.19	23.3	24
Furnace productivity, tons/day	1915.3	1999.5	2044.0	2023.0
Intensity of combustion of (dry) coke, kg/m^3	902.0	930.0	954.0	962.0
Productivity factor, m^3/ton*	0.723	0.693	0.678	0.685
Intensity of blast, m^3/min per m^3 of	652.4	646.0	647.0	661.0
furnace volume	1.700	1.690	1.668	1.626
Blast:				
consumption, m^3/min	2355	2354	2310	2249
humidity, g/m^3	20.6	20.0	20.15	21.3
pressure, atm. gage	1.78	1.78	1.82	1.83
temperature, °C	840	884	885	873
Blast-furnace gas:				
pressure, atm. gage	0.62	0.66	0.64	0.63
temperature, °C	310	301	285	293
CO_2, %	13.4	14.6	14.99	15.28
CO, %	28.72	29.40	30.55	30.94
CO : CO_2 ratio	2.14	2.01	2.03	2.02
calorific value, cal/m^3	946	973	1002	1002
Composition of pig iron, %				
Si	0.64	0.56	0.57	0.61
Mn	0.98	0.90	0.86	0.93
S	0.042	0.046	0.048	0.044
P	0.18	0.20	0.19	0.19
Slag yield, kg/ton pig iron	630	577	613	639
Composition of slag, %				
SiO_2	36.54	36.30	36.02	36.36
Al_2O_3	17.95	17.88	17.70	18.05
CaO	36.30	36.79	37.21	37.33
MgO	6.19	6.20	6.19	5.64
CaO : SiO_2 ratio in slag	0.99	1.01	1.04	1.03
Dust yield, kg/ton pig iron	93.0	89.0	72.0	81.6
Consumption kg/ton pig iron:				
metallic additions	39.0	40.0	34.0	42.0
lime	127.0	105.0	128.0	135.0
iron ores	1835.0	1826.0	1835.0	1854.0

* Useful volume of furnace in m^3 divided by daily output of iron in tons. Translator's note.

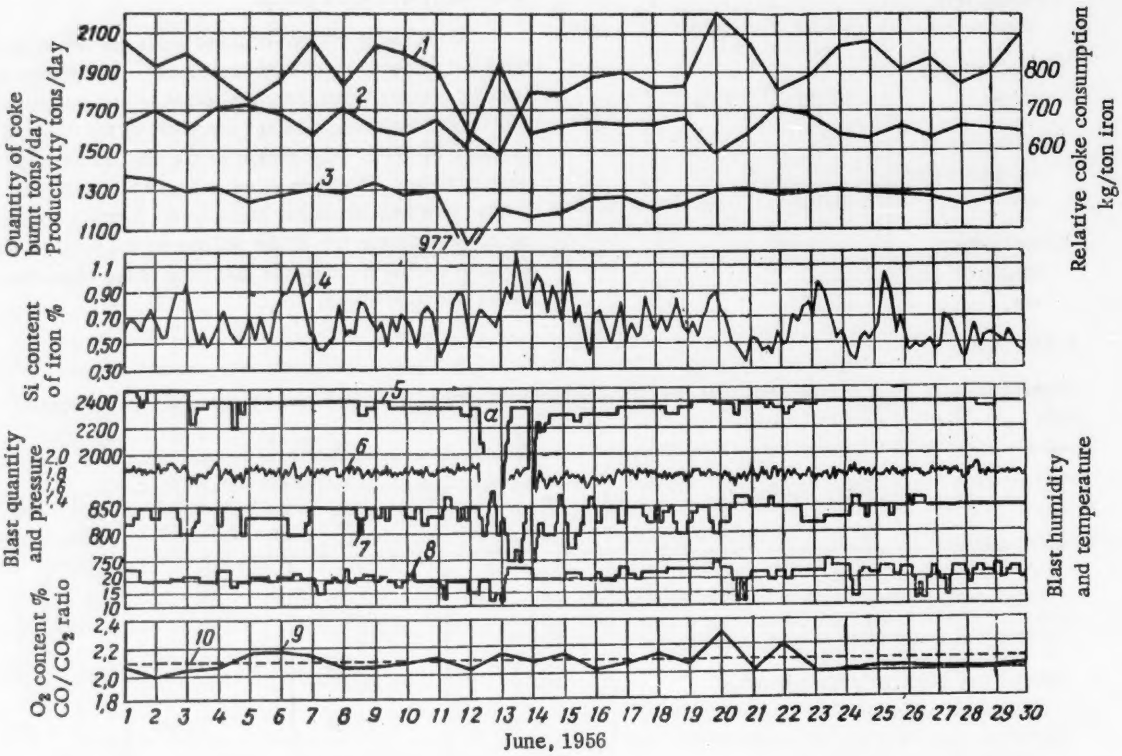

Fig. 1. Principal working factors of the blast furnace using ordinary blast. Letter a denotes a period of slow working.
1) productivity of furnace, tons/day; 2) coke consumption, kg/ton; 3) quantity of coke burnt, tons/day; 4) silicon content of pig iron, %; 5) blast consumption, m^3/min; 6) blast pressure, atm. gage; 7) blast temperature, °C; 8) blast humidity g/nm^3; 9) CO/CO_2 ratio in gas; 10) oxygen content of blast (21%).

It should be noted that with oxygen-enriched blast, the foremen were obliged to assess the working of the furnace mainly by the readings of the control instruments, since the tuyere flames were too bright to be used as indication of the thermal condition of the hearth.

The foremen kept a more careful watch than usual on the distribution of the gas streams in the furnace. The curves showing the CO_2 distribution over the throat radius, reproduced in Fig. 3, confirm the satisfactory utilization of the thermal and chemical energy of the gas during the entire smelting period.

Retaining the previous ore load (about 2.6), with the blast enriched with oxygen to 24.0%, the quantity of tappings of pig iron with a low silicon content (below 0.4%) was greater than with ordinary blast. Consequently, the thermal condition of the lower levels of the blast furnace was adequate. The principal cause of this is the relative reduction in the amount of gas, which produces a lowering of the temperature in the furnace shaft and impairs the conditions for indirect reduction.

A worsening in the quality of the raw materials in the final period caused the blast-furnace men to have to lighten the ore load somewhat and thus to increase the coke consumption.

TABLE 3

Factors	Ordinary blast	Enriched blast
Productivity in commercial pig iron, tons/day	399.7	447.0
Specific consumption of dry coke, kg/ton	1492	1462
Blast temperature, °C	1000	998
Composition of pig, % Si	0.85	0.77
Mn	77.4	73.4
Smelting intensity $\frac{\text{kg coke}}{\text{m}^3 \cdot \text{days}}$	543	593

• Excluding metal not to specification.

Since the coke consumption as a whole did not vary during the experimental smelting operations, the increase in productivity with oxygen-enriched blast was due to the intensification of furnace working in proportion to the amount of additional oxygen introduced. The average increase in productivity for 14 days of working on blast enriched with 23.3% of oxygen was 6.72%. On increasing the oxygen content of the blast to 24%, the working factors of the furnace deteriorated, since the quality of the raw materials depreciated (mainly the Vysokogora sinter), and on 16th August, 1956, the furnace operation was disturbed through causes unconnected with the use of oxygen. Before the impairments in the sinter quality from the 11th to the 15th of August, the productivity of the furnace of blast enriched with 24% of oxygen increased to 2063 tons per day. It may be assumed that this degree of enrichment of the blast is not the limit.

Due to the high cost of commercial oxygen at the Novo-Tagil Combine (15 kopecks per 1 m^3), the cost of the pig iron when using oxygen-enriched blast was somewhat higher than when smelting with ordinary blast. When using oxygen blast, however, the amount of top dust was decreased, the calorific value of the blast furnace was higher and steel making losses were less.

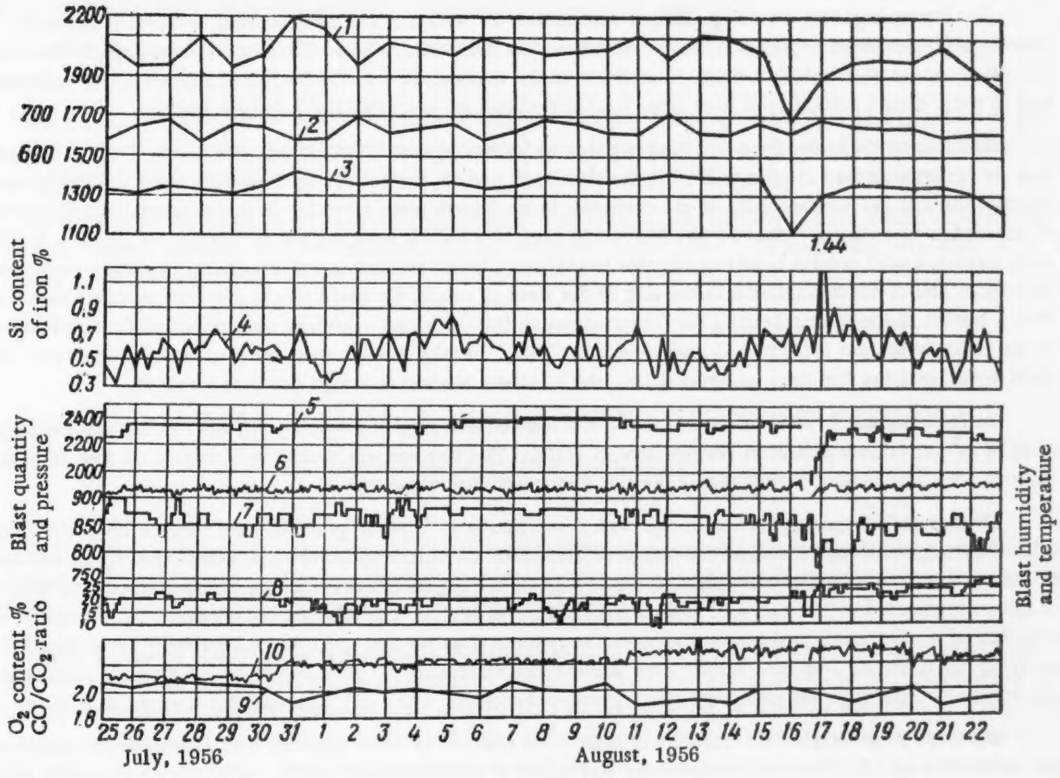

Fig. 2. Principal operating factors of blast furnace No. 4 on oxygen blast. 1) productivity of furnace, tons/day; 2) coke consumption, kg/ton; 3) quantity of coke burnt, tons/day; 4) silicon content of pig iron, %; 5) blast consumption, m^3/min; 6) blast pressure, atm. gage; 7) blast temperature, °C; 8) blast humidity g/nm^3; 9) CO/CO_2 ratio in gas; 10) oxygen content of blast (21 %).

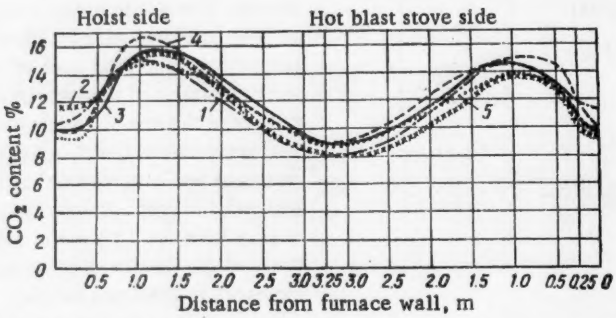

Fig. 3. Carbon dioxide content in gas over top radius during operation of the furnace.
1) on ordinary blast from 1st to 30th June, 1956; 2) on blast with 22.2% O_2 from 25th to 30th July, 1956; 3) on blast with 23.3% O_2 from 31st July to 10th August, 1956; 4) on blast with 24% O_2 from 11th to 19th August, 1956; 5) on ordinary blast from 6th to 25th September, 1956.

Ferromanganese Smelting with Acid Slags

For ferromanganese smelting, Chiatur manganese ore with a manganese content of 42-46% was used. The content of hygroscopic moisture in the ore varied within the limits 8-14%. The ore contained much fine material (51.6% of the fraction below 3 mm). In addition to the manganese ore, the burden contained metal additions and to some extent dolomitized lime from the Lebyazhinsk area, containing 2.5-7.0% MgO.

Before changing over from smelting pig iron to ferromanganese, the furnace was blown down in preparation for ferromanganese smelting. During the shut down period, the following steps were taken. Taking into account the low gas-permeability of the materials in the hearth when smelting ferromanganese, the diameter of all twelve tuyeres was reduced from 200 to 180 mm. To reduce external loss of heat at the tuyeres, the latter were insulated with several layers of asbestos board; the asbestos insulation was contained in a sheet-iron casing. To reduce loss of ferromanganese in the slag in the form of beads, the main slag gutter was provided with a dam with a branch channel for releasing the ferromanganese from the trap. Devices were provided for supplying water to the skips, in the gas offtakes and under the large bell. To take into account the possibility of increased dust yield when smelting the dusty manganese ore, the hood was washed in a high-pressure scrubber.

Before changing over to ferromanganese, the furnace was smelting foundry pig with a blast consumption of 2100 m^3 per minute at a blast temperature of 800°C. The furnace was heated by charging 90 tons of coke without ore. The burden of manganese ore was then gradually raised to 1.4.

Despite preliminary reduction in the blast consumption to 1800 m^3 per min., the furnace operated irregularly as the manganese ore arrived at the center of the shaft. Channelling occurred, accompanied by an increase in the top dust (up to 50% of the weight of ore charged). To regularize the working of the furnace, the quantity of blast was reduced to 1250 m^3/min and its temperature to 600°C. The shift foremen worked out a rational distribution of the materials and gas streams over the furnace cross section and selected optimum conditions for charging the furnace. The best results were obtained by increasing the coke supply to 5.8 tons and alternating the burden systems coke-ore-ore-coke and ore-ore-coke-coke. The stock line was also lowered to 2.75 m.

All these steps enabled the quantity of blast to be restored to 1450 m^3/min. with simultaneous raising of the ore burden to 1.5. The blast temperature was raised to an average of 1000°C. With the conditions as worked out, the operation of the furnaces became regular, ensuring the production of ferromanganese to specification, with a low specific coke consumption.

In one of the smelting periods over the course of a month oxygen was introduced into the blast. Table 3

above gives the principal operating factors of smelting with ordinary blast and with oxygen-enriched blast.

Thus, enriching the blast with 24.3% of oxygen enabled the productivity of the furnace to be increased by 11.2%.

In both periods, smelting of ferromanganese showed a number of important features.

The high content of fines in the ore did not permit the operation of the furnace to be intensified by increasing the amount of blast; therefore smelting was conducted on acid slags and high ore burdens. Working with slags having the ratio $\frac{CaO + MgO}{SiO_2} = 1.10 - 1.15$ assisted in reducing the relative yield of slag and consequently in improving the gas-permeability of the column of charge. Furthermore, with such working conditions, the coke consumption was fairly low. This was also due to the increased top gas pressure (0.4-0.5 atm. gage) and high blast temperature.

Since the coke ash contained much phosphorus, a low coke consumption was a necessary condition for the production of ferromanganese to specification according to the phosphorus content. The blast temperature attained (1000-1050°C) was not the limit temperature from the point of view of preserving regular working of the furnace. Further increase in blast temperature, however, was limited by the inadequate heat capacity of the hot-blast stoves and the durability of the tuyeres. When the blast temperature was increased to 1050°C for a short time, partial deformation of some of the tuyeres was observed. Therefore, when smelting ferromanganese, it is preferable to use hollow, machined tuyeres, with an internal tube of heat-resistant steel of the type used at the Magnitogorsk Metallurgical Combine, "Zaporozhstal" works and elsewhere.

The working conditions described ensured normal service of the tuyeres, slag equipment and top equipment.

The degree of reduction of manganese to ferro-alloy is 81.26%. Some increased loss of manganese in the form of MnO in the slag, compared with other works where smelting was on basic slags, is offset by low manganese loss in dust and through volatilization.

The results of the experimental smelting operations illustrated the expediency of introducing oxygen into the blast in furnaces smelting prepared charges. For this purpose, high-capacity oxygen plants will have to be built at the blast furnace works.

COMPLEX AUTOMATION OF HOT BLAST-STOVES AT THE KUZNETSK METALLURGICAL COMBINE

In 1956, at two blast furnaces of the Kuznetsk Metallurgical Combine, automatic control was adopted for the following: regulation of the heating conditions of the hot-blast stoves, regulation of temperature and humidity of the hot-blast and control of the reversing valves of the hot-blast stoves.

Figure 1 shows a diagram of the automatic heating control of the hot-blast stoves. The quantity of blast supplied to the furnace is recorded by the consumption meter 1. The dome and checkers of the hot-blast stoves of the blast furnace are heated by cleaned blast furnace gas, the consumption of which is measured by a segment diaphragm and the recording consumption meter 2. The gas pressure in front of the diaphragm is measured by the membrane pressure gage 3. Constant gas pressure is maintained in the common gas main by means of an indicating, annular differential pressure gage 4 with an inductive pick-up and electronic pressure regulator 5, type ERK-77. The throttle valve is operated by a control mechanism 6, type IMT-25/120, whereupon the gas passes through a gas-regulating throttle 7 and the gas shut-off slide 8 to the hot-blast stove burner. Air from the blower 9 is supplied to the burner for the combustion of gas. The gas pressure in front of the burner is measured by the annular differential pressure gage 10.

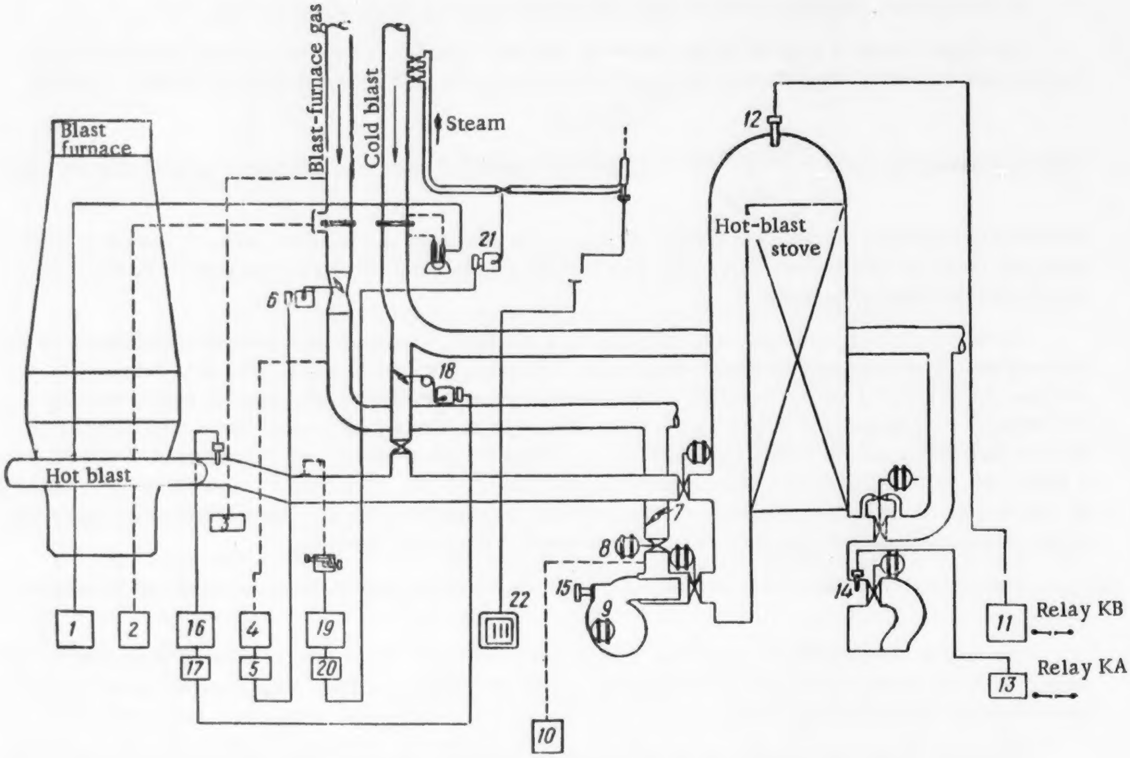

Fig. 1. Basic diagram of the automatic regulation of heating of hot blast stoves. 1) blast consumption meter; 2) gas consumption meter; 3) blast furnace gas pressure gage; 4) annular differential pressure gage; 5) electronic pressure regulator; 6) servomechanism; 7) gas-regulating butterfly valve; 8) gas shut-off slide; 9) blower; 10) annular differential pressure gage; 11) electronic regulator; 12) thermocouple; 13) electronic regulator; 14) thermocouple; 15) photocell; 16) potentiometer for temperature measurement; 17) isodromic regulator; 18) servomechanism; 19) humidity pick-up; 20) isodromic regulator; 21) servomechanism; 22) apparatus for measuring steam consumption, pressure and temperature.

Since the gas pressure is regulated in the common gas main, it is not necessary to mount a combustion regulator to each burner.

The quantity of gas entering the burner is supplied by the gas-regulating butterfly valve 7, and the quantity of air is regulated by the speed of the blower 9. The angle of opening of the butterfly and the speed of the blower are interconnected, so that gas and air enter the burners in a predetermined ratio.

The butterfly valve and blower are controlled automatically according to the reversal diagram of the valves. The thermal conditions of the hot-blast stoves are adjusted periodically according to flue gas analysis.

The dome temperature is regulated by an electronic two-position regulator 11 with a chromel-alumel thermocouple 12 type TX-VIII, mounted in the dome. If the temperature below the dome exceeds the predetermined temperature, the contact of regulator 11 closes and connects a relay KB in the blower control circuit.

The blower supplies more air for the same quantity of gas as before; the dome temperature falls, and the bottom layers of the stove checkers are heated better. With decrease in the dome temperature, the system returns to the predetermined position. This process is repeated until the checkers are heated throughout the entire height of the hot-blast stove, after which the flue-gas temperature begins to rise. If it is still early to put the hot-blast stove on blast, the flue-gas temperature regulator partly reduces the supply of gas and air, i.e., it puts the stove in a condition of "low gas" and will keep it in this condition until it is changed over to "blast."

The flue-gas temperature is regulated by electronic regulator 13 with a chromel-alumel thermocouple 14 type TX-XIII, mounted in front of the flue gas valve. If the flue-gas temperature rises, the contact of electronic regulator 13 closes and closes relay KD in the blower control circuit, which reduces the blower speed and closes the butterfly 7 to a predetermined angle. In automatic operation, the necessary heating conditions of the hot-blast stove may be selected to take into account the dome temperature and the flue-gas temperature. It is necessary to maintain a predetermined flue-gas temperature in order to preserve the flue-gas valves.

To prevent explosions in the combustion of the gas, a photocell 15 is mounted in the burner. If the flame disappears and there is a risk of an explosive mixture being formed under the dome, the photocell operates and closes an isolating valve.

The hot-blast stove can work in the following conditions:

<u>Condition of forced combustion of gas</u> in which the burner blower supplies the maximum quantity of air, and the maximum quantity of gas passes the gas-regulating butterfly valve.

<u>Working condition</u> in which the quantity of air is regulated according to the dome temperature.

<u>"Low gas" condition</u> in which the air supplied by the blower and the gas are regulated according to the flue-gas temperature.

Constancy of blast temperature is ensured by the electronic regulating potentiometer 16 operating as a unit with a chromel-alumel thermocouple in the hot-blast main and with an isodromic regulator 17, type IR-130. The pulse is transmitted to the servomechanism 18, type IMT-25/120, which operates the butterfly valve in the mixing air-pipe, varying the addition of cold air to the hot-blast main. This mechanism can be controlled by push-button on the heat control panel.

The predetermined humidity of the blast is regulated by an electronic regulating bridge, operating as a unit with the humidity pick-up 19 and with the isodromic regulator 20, type IR-130. The latter controls the servomechanism 21, type IM-2/120, connected with the regulating valve on the steam pipe.

Steam is introduced into the cold blast air main after the snort valve. The air for determining the humidity is taken from the hot-blast main.

The humidity pick-up designed at the Kuznetsk Metallurgical Combine operates with low-inertia, sensitive platinum resistance thermometers. Measurement of steam consumption, pressure and temperature is effected by means of a triple-scale electronic instrument 22, specially made at the Kuznetsk Metallurgical Combine.

The introduction of complex automation of the hot-blast stoves has made it necessary to modernize all their equipment for use with electric drives.

To increase the heat capacity of the hot-blast stoves, the gas burners with a capacity of 24,000 m^3 of air per hour were replaced by more powerful burners with blowers having a capacity of 40,000 m^3 per hour (Fig. 2). The blower has righthand rotation and is driven via a flexible coupling by a 40 kilowatt electric motor with a variable speed of 600- 1500 r.p.m. The pressure produced by the blower is 200 mm water gage. Due to its simplicity and relatively small dimensions and to the double-bearing shaft, a blower of this construction is more reliable in operation and more convenient to service than the blowers of gas burner UZTM and the modernized burner IZTM.

The gas burner is separated from the hot-blast stove by the isolating valve 1 (Fig. 2) of sliding plate type having a diameter of 1100 mm, the construction of which is similar to that of the hot-blast slide. The plate and supporting ring of the valve are watercooled, so that the surfaces in the vicinity of the shaft are not distorted and the joints remain gas-tight. The isolating valve is operated by means of an electric winch and cable. The valve disk takes 12 seconds to be lifted or lowered at a speed of 6 m/min.

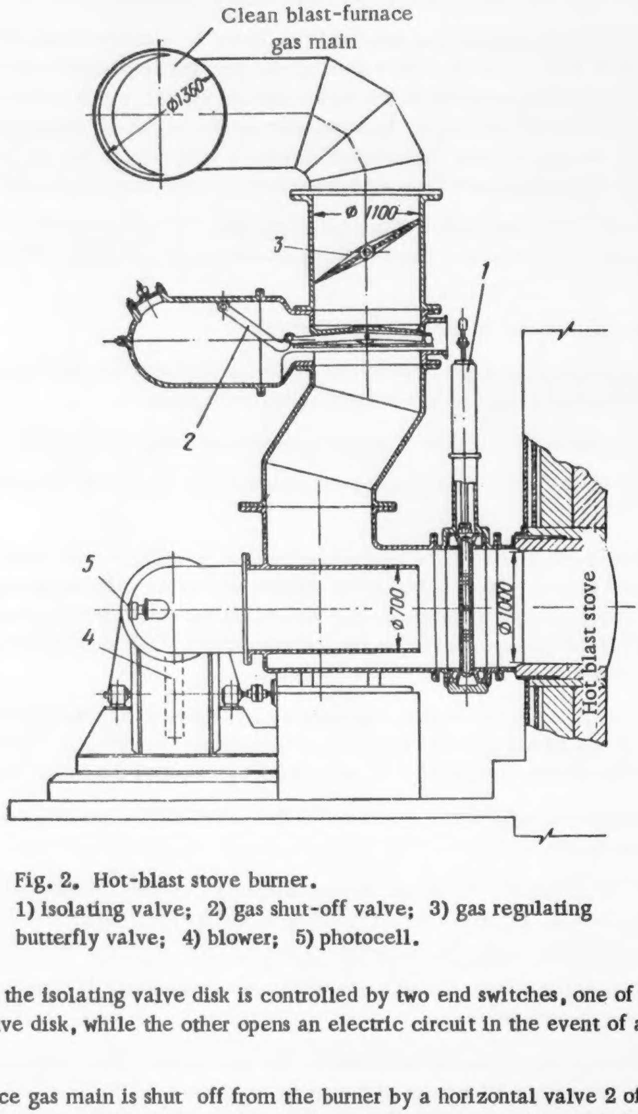

Fig. 2. Hot-blast stove burner.
1) isolating valve; 2) gas shut-off valve; 3) gas regulating butterfly valve; 4) blower; 5) photocell.

The position of the isolating valve disk is controlled by two end switches, one of which determines the full closure of the valve disk, while the other opens an electric circuit in the event of a sudden weakening of the lifting cable.

The blast furnace gas main is shut off from the burner by a horizontal valve 2 of the crank-plate type, with a diameter of 1100 mm. It has been modernized somewhat in comparison with the type valve IZTM. The housing of the valve has been made stiffer to increase the gas-tightness, and the closing time of the valve has been reduced as the result of a modification in the ratio of the lever arms of the crank transmission. The drive of the valve has been positioned directly on its housing, resulting in a rather better accuracy of assembly and ensuring constancy in the geometrical dimensions of the crank mechanism.

Above the shut-off valve of the gas burner is a gas-regulating butterfly valve 3 with a diameter of 1100 mm. It is actuated off a servomechanism type IMT-50/440 by means of a cable. There is also a handwheel for operating the valve; it takes 70 sec. for full opening. Rotation of the butterfly valve is limited by a control apparatus type KA-4054 mounted directly on the valve.

To prevent gas and hot air escaping through leaks in the gas shut-off valve and isolating valve, a special exhaust pipe 100 mm in diameter is mounted on the gas supply main. It is provided with a throw-over cock of the barrel type, connected by a cable to the disc of the isolating valve. When the latter is closed, the cock is open and the system formed by the gas main and burner is connected by the exhaust pipe to the atmosphere. When the burner is working, the isolating valve is open and the cock is shut.

On the supply gas-main of a group of hot-blast stoves is a gas-pressure regulator, butterfly valve 1000 mm in diameter, which is operated by a servomechanism type IMT-25/120. The drive is designed so that if the voltage on a group of hot-blast stoves fails, the butterfly valve is released from an electromagnetic locking device and closes under its own weight and shuts off the supply of gas to the burners, the blowers of which stop at the same time.

The hot-blast stoves are shut off from the cold-blast main by vertical disc valves 1100 mm in diameter.

The hot-blast stoves are shut off from the hot-blast main by a hot-blast sliding valve 1100 mm in diameter. The valve housing disk and rings are welded from sheet steel. The valve is watercooled. The rings are divided in half by partitions; the water enters at the bottom and leaves at the top, thus preventing the formation of steam locks in the cavities of the cooled parts. The valve disk is provided with an internal spiral partition for the same purpose. The valve is lifted by an electric crane and cable. The duration of lift or descent is 12 sec., speed 6 m/min. The position of the vavle is controlled by an end switch KU-131-A, which opens an electric circuit in the event of sudden weakening of the lifting cable (breakage of the cable or jamming of the valve during descent).

The hot-blast stoves are separated from the stack flue by two vertical flue valves, the construction of which is similar to that of typical flue valves made by IZTM.

For air release each hot-blast stove is provided with a vertical type release valve, 430 mm in diameter, the electric drive of which is mounted on its housing; time required for lifting or lowering the valve plate is 20 sec.

Automation of the hot-blast stoves has increased their efficiency by about 10%. The time required for reversing the valves, which was 25-30 min., has been reduced to 3-6 min.

Automatic control has combined all the 40 mechanisms of the group of hot-blast stoves in one system. This has made it possible to select the most constant thermal conditions, eliminate heavy manual operations and to combine the groups of hot-blast stoves not only with each other but also with the entire gas system.

The conversion of the hot-blast stoves to a single automatic complex has made it possible to increase to the maximum amount the temperature of the blast supplied to the blast furnaces.

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ALL-UNION CONFERENCE OF BLAST-FURNACE MEN AND SINTER PLANT OPERATORS

The All-Union Conference of Blast-Furnace Men and Sinter Plant Operators took place in Dnepropetrovsk from March 26th to the April 2, 1957. Five hundred delegates gathered at the Conference from all parts of the country and from abroad and many guests also came from plants and educational and training institutions. In contrast to previous conferences in 1946 and 1954, all the reports were previously printed and distributed to the participants and were not read through at the conference. Much time was thereby saved.

Forty-one reports were presented at the conference. One hundred eighty-six people contributed to the discussions.

The second distinctive feature of the gathering was the enormous amount of attention paid to questions of ore preparation for the blast furnace. Seven out of the ten reports presented at the plenary session were devoted to these questions.

The conference opened with the report of the Deputy Minister of the U.S.S.R. Ministry of Ferrous Metallurgy, V. B. Khlebnikov. He recorded the great achievements of Soviet blast-furnace men during the two and a half years since the last conference. In 1956, the blast furnace coefficient was 0.78 and the country's daily output of pig iron reached 100,000 tons. The annual growth of productivity during the last three years was 2,600,000 tons, half of which was achieved by improving the operations of existing plants.

The best results were attained by the crew operating blast furnace No. 7 at the Magnitogorsk iron and steel combine which produced an average of more than 2,300 tons of pig iron per day in some months of 1956.

The percentage of sinter in U.S.S.R. blast furnace burdens increased up to 66%, 87% of the sinter being self-fluxing.

Coke consumption in the production of pig iron for steelmaking was reduced from 888 kg per ton in 1954 to 812 kg per ton in 1956 and the output of flue dust was substantially curtailed. Improvement in furnace operations was due to the introduction of new techniques: the number of blast furnaces operating at high top pressure increased to 52, while 98 furnaces went over to high temperature, moistened blast. The smelting of low manganese pig iron increased considerably and this is now established at a number of southern plants also.

Comrade Khlebnikov also drew attention, in his report, to shortcomings in the development of blast furnace production, both as regards organization of the work of individual blast furnace plants and in the activities of scientific research institutions as regards the investigation and introduction of new, high productivity methods of operating. Work on high top pressure above 1 atm gage is progressing slowly; the degree of self-fluxing of sinter at many of the southern sinter plants is inadequate.

Work in the mines still involves heavy physical labor: research workers and planners do not pay sufficient attention to the mechanization of mining. Comrade Khlebnikov dwelt in some detail on questions of reducing the net cost of pig iron and sinter, of increasing the productivity of labor and also on the basic problems of blast-furnace men in the near future.

At the conference, there was lively discussion of the reports of Comrades Marinenko, Titkov and Karmazin devoted to the beneficiation of iron ores. Those who took part in the conference were unanimous in emphasizing how important it was to speed up the introduction of new methods of ore concentration — magnetic roasting, flotation and heavy media concentration. In the building of new installations and the reconstruction of existing ore concentration plants, it is essential to use methods which will ensure the production of concentrate with a minimum iron content of 60% and silicon not higher than 10%.

The reports of Comrades Eliasberg, Kharash and Parfenov, Abramov, Uryupin, the Grigoryevs and others threw some light upon the design of sinter machines, perfection of the sintering process and especially the sintering of very fine concentrates. It was recommended that there should be systematic addition of burnt lime to the sinter burden, that double layer sintering should be developed, that the coarseness of materials sent for sintering be considerably reduced, that the transfer of sinter in special wagons should be organized and that conditions of sinter cooling at the plants should be improved. Members of the conference agreed that the building of sinter machines with a sintering surface area of 200 sq m should be speeded up.

The reports of Comrades Trekalo, Onoprienko, Miller, Machkovsky and others were devoted to the results of trials with self-fluxing sinter in blast furnaces. The conference recommended that operational scale and research work relating to the production of highly basic, high strength and easily reducible sinter be continued.

Comrades Bazanov and Rudkov gave interesting reports on gaseous sintering. The section of sinter plant operators discussed a number of reports on the automation of individual sections of the sintering process and on the prospects of introducing fully integrated automatic control.

At three sessions of the blast furnace section, Comrade Leonidov's report on the plans for blast furnaces with an effective volume of 2286 and 1719 cu m were discussed. Thirty-six people contributed to the discussion of the report. The Gipromez design of blast furnace having an effective volume of 2286 cu m was substantially criticized (Comrades Ramm, Tsifranovich, Tsaplev, Sorokin and others) as also were the Gipromez design for a built-up big bell (Comrades Berman, Abramovich, etc.) and the Gipromez version of conveyer belt feed of materials to the furnace top (Comrades Levin, Khilkevich, Kutner and others). The conference recommended that when the planning of furnace performances and ratings had been completed, the specifications should be specially examined.

There was active discussion of the reports of Comrades Oreshkin, Kochin, Fofanov and Gavrilyuk on the operation of blast furnaces with experimental lines. The question of the advantages of stack cooling with plate coolers, as installed on two of the Dzerzhinsk furnaces came in for special discussion. The conference decided that a special committee should undertake further study of the technical and economic results of utilizing this design.

Great interest was aroused by the reports of Comrades Shapovalov and Khilkevich on the smelting of iron with oxygen-enriched blast and by Khilkevich's supplementary contribution regarding the production of ferromanganese with oxygenated blast at the Nizhne Tagil iron and steel combine.

Voskoboinkov's report on desulfurization outside the blast furnace aroused lively discussion. Conference members who took part in the discussions emphasized the necessity of finding a cheap and highly productive method of desulfurizing outside the furnace and a number of valuable suggestions were made.

Comrade Basov, in his report, threw light upon questions of automation of the blast furnace process. He reported work on integrated automation which was presently being carried out by scientific research and educational institutions and he acquainted members of the conference with the automation program for the near future.

Neshcheret and Ratner reported to the blast furnace contingent on how repair work at the leading blast furnace and sinter plants was organized so as to lower operating costs, cut down the amount of equipment and reduce down time on basic plant units.

The final plenary session all reports were unanimously accepted.

Some of the reports discussed at the conference will be printed in our journal.

DEOXIDATION OF RIMMING STEEL BY FERROMANGANESE IN THE LADLE

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The deoxidation of rimming steel in the ladle has not previously enjoyed wide application on account of the doubts which arise as regards the possibility of obtaining high grade metal by this method although, with such a method of deoxidation, manganese losses can obviously be reduced and thus the consumption of ferromanganese can be lowered.

On the basis of research carried out in 1955, the deoxidation of rimming steel by ferromanganese in the ladel was introduced in the open hearth shop of the Stalin iron and steel plant.

Rimming steel is produced in basic open hearth furnaces with magnesite-chrome roofs by the scrap and ore process, using hot metal to the extent of 60 to 65% by weight of the metallic charge. Furnaces with a high thermal input (consuming up to 22,000,000 cals per hour) are fired by mixed (coke oven and blast furnace) gas. Slag is pulled twice— during melt-down and refining— over the center charging door sill. Metal is tapped into a single ladle and is bottom poured into 0.9 to 3.4 ton ingots, six and eight to a bottom plate.

With the exception of deoxidation practice, these trial heats were produced in accordance with the technological instructions relating to the melting and teeming of rimming steel. Ferromanganese was added either through a chute into the tapping spout during tapping or by hand into the metal stream as soon as the ladle is one-third full.

The primary essential during the trial heats was to examine the following questions:

1) homogeneity of the chemical composition of the metal;

2) permissible silicon content of the ferromanganese;

3) variation of carbon content of the metal with ladle deoxidation;

4) effect of deoxidation in the ladle on steel quality (mechanical properties, surface finish);

5) economic effect of the new method of deoxidation.

The homogeneity of metal composition with ladle deoxidation was checked on 25 heats and, for comparison, on 9 heats deoxidized with ferromanganese in the furnace.

Results of chemical analysis showed that the distribution of manganese and silicon in the metal with ladle deoxidation is the same as with furnace deoxidation and variation in the contents of these elements does not exceed the limits of permissible error in chemical analysis (0.02 to 0.03%). In all cases without exception, the silicon and manganese contents were within the limits specified by GOST.

In all cases of deoxidation, even when ferromanganese containing 2.1% silicon was used, the silicon content of the finished metal did not exceed 0.030%. There was, moreover, no deterioration in the casting behavior of the metal.

When low carbon rimming steel (Sv08, Sv08A) was deoxidized with ferromanganese in the ladle using amounts of up to 1000 kg (8.0 kg per ton), there was no increase in the carbon content of the metal. In all the heats deoxidized with ferromanganese in the ladle, the carbon content of the finished metal (ladle sample) remained the same as at the commencement of tapping. This apparently is due to the fact that the increase in carbon content on account of ferromanganese is compensated for by the loss of carbon at tapping which is consumed in the self-deoxidation of the metal. The absence of carbon pick-up by the metal when ferromanganese is added to the ladle makes it possible to melt low carbon rimming steels with carbon contents of up to 0.10% without the necessity of attaining very low carbon content in the bath prior to tapping.

From the average data in Table 1, it is seen that, during deoxidation and tapping, the lowering of the sulfur content and the reduction of phosphorus are less with deoxidation in the ladle than with deoxidation in the furnace.

TABLE 1

Variation in Sulfur and Phosphorus Contents of the Metal

Method of deoxidation	Steel	Number of casts	Content in metal (%)				Variation during deoxidation and holding *	
			before tapping		in the ladle			
			S	P	S	P	S	P
In the ladle	3 kp 2 kp;Sv08	56 16	0.048 0.035	0.022 0.020	0.045 0.032	0.023 0.021	—0.003 —0.003	+0.001 +0.001
In the furnace**	3kp 2kp	25 6	0.048 0.043	0.018 0.021	0.041 0.038	0.023 0.024	—0.007 —0.005	+0.005 +0.003

* + increase; − decrease.

** Sulfur and phosphorus contents before addition of ferromanganese to the furnace.

In this connection, when rimming steel is deoxidized in the ladle, it is essential that the process be carried out so that, at tapping, the sulfur content of the metal does not exceed the maximum permissible sulfur content of the finished steel.

TABLE 2

Manganese Losses and Consumption of Ferromanganese with Various Methods of Deoxidation

Method of deoxidation	Steel	Number of heats	Content in metal (%)				Weight of liquid metal in tons	FeMn concumed kg		Loss from FeMn, %	In relation to consumption, kg per ton*
			before deoxidation		in the ladle			per heat	per ton of steel		
			C	Mn	C	Mn					
In the ladle	3kp Sv08;2kp	64 16	0.18 0.10	0.24 0.19	0.17 0.11	0.38 0.39	130.30 131.12	517.0 680.0	3.97 5.20	53.5 49.0	4.3 6.3
In the furnace	3kp Sv08	57 10	0.19 0.08	0.25 0.16	0.18 0.09	0.406 0.410	129.4 132.9	854.0 1895.0	6.60 14.2	68.0 76.5	6.3 13.0

* In order to obtain comparable results, the consumption of ferromanganese is related to the Mn content of the finished steel which is equal to 0.40%.

The influence of individual factors on the extent of manganese losses with deoxidation in the ladle was studied in two hundred current production heats. The data on manganese losses from ferromanganese and the consumption of ferromanganese with ladle deoxidation and furnace deoxidation are presented in Table 2 and show that when rimming steel is deoxidized in the ladle, the consumption of ferromanganese is substantially reduced. Thus, when 3kp steel is deoxidized in the ladle, the consumption of ferromanganese per ton of liquid

steel averaged 4.3 kg per ton while, in the heats deoxidized in the furnace, it was almost 150% higher (6.3 kg per ton).

When low carbon rimming steel was deoxidized in the ladle, the consumption of ferromanganese was 6.3 kg per ton, but with furnace deoxidation it was 13 kg per ton.

With ladle deoxidation, the number of factors affecting manganese losses is reduced. Manganese is oxidized only by the action of the slag in the ladle and, consequently, the manganese loss depends on the period of holding in the ladle. A reduction in the number of the factors affecting manganese losses reduces these losses and lowers the consumption of ferromanganese.

100 kg of ferromanganese is added to the metal (for a 130-ton heat) averaging about 0.03% Mn. This facilitates the determination of the quantity of FeMn required for deoxidation in the ladle and ensures tighter control of the maganese content in the ladle sample than is possible with deoxidation in the furnace. This results in a marked reduction in the number of "bootleg" ingots and makes it easier to work to a closer carbon tolerance.

Trial heats and long practical experience of the shop showed that metal temperature at tapping must not behigher with ladle deoxidation than it is with furnace deoxidation (1600 to 1620°C) as measured with the immersion pyrometer.

The quality of the steel produced by ferromanganese deoxidation in the ladle was evaluated according to the surface condition of the sheets, the mechanical properties and the macrostructure.

The surface of sheets rolled from ingots of ten trial heats was completely satisfactory. Only 11 out of 1102 of the sheets examined had to be dressed on account of cracks, i.e., something less than 1%, while an average of 8% of the sheets produced from the heats which had been deoxidized in the furnace had to be dressed.

Average results of mechanical tests of the steel of the trial heats deoxidized either in the furnace or in the ladle (Table 3) showed that the deoxidation of rimming steel by ferromanganese in the ladle does not adversely affect the mechanical properties of the rolled product. An examination of the macrostructure of bars taken from the rolled product corresponding to the top of the ingot from 12 heats (72 bottom poured ingots) of Sv08 steel deoxidized in the ladle, showed that the structure of the rolled metal was quite sound. In all sections selected for examination the rim zone was 20 to 30 mm wide (on 130 × 130 mm square section) with fine blow holes at the boundary of the segregated square. The distribution of sulfides in the rim zone was fairly uniform.

Thus, it is established that the doxidation of rimming steel by ferromanganese in the ladle has no adverse effects on metal quality.

Due to a reduction in the consumption of ferromanganese and in tap-to-tap time by eliminating the period of deoxidation in the furnace (average period of deoxidation in the furnace is fifteen minutes), steel costs are lowered by deoxidizing in the ladle.

Plant data show that there is a saving of 8 rubles for each minute of tap-to-tap time saved. Thus, if tap-to-tap time is cut by fifteen minutes for an average 132 ton heat, the reduction in cost per ton of steel is:

$$\frac{15 \times 8}{132} = 0.91 \text{ rubles.}$$

TABLE 3

Average Results of Mechanical Tests of Rimming Steel Heats for the Production of Sheet

Method of deoxidation	Number of heats	Tensile strength σ_B in kg/mm²	Yield point σ_S in kg/mm²	Elongation δ in %	Chemical composition, %	
					C	Mn
In the ladle	40	42.21	27.51	27.35	0.17	0.39
In the furnace	39	42.46	28.20	26.0	0.18	0.41

According to the data in Table 2, ferromanganese consumption for deoxidation in the ladle of 3kp steel is reduced by 2 kg per ton while, for low carbon steel (Sv08, 2kp), there is a reduction of 6.7 kg per ton. With the cost of ferromanganese at 973.6 rubles per ton, total reduction in cost per ton of steel, with deoxidation in the ladle, compared with deoxidation in the furnace, is as follows:

(a) for 3kp steel,

$$0.91 + 2(2 \times 0.9736) = 2.85 \text{ rubles;}$$

(b) for low carbon rimming steel,

$$0.91 + (6.7 \times 0.9736) = 6.52 \text{ rubles.}$$

At present, 70% of all rimming steel is deoxidized by ferromanganese in the ladle. Deoxidation in the furnace is used only for heats with a high sulfur content in the steel during refining. Calculations showed that the deoxidation of rimming steel in the ladle effects an annual saving of more than 600 tons of ferromanganese.

THE EFFECT OF OXYGEN ON THE QUALITY OF MILD RIMMED STEEL

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Giprostal

There is no one agreed opinion among metallurgists as to the effect of oxygen on the mechanical properties of mild rimmed steel. Some researchers maintain that with the increase of oxygen content in steel its mechanical properties are impaired; others consider that the compound of iron and oxygen in the form of a lower oxide has the most harmful effect on the quality of steel, the oxide forming a film on the grain boundaries and disrupting the continuous crystalline structure. The majority of researchers assume that the amount of oxygen in rimmed steel should be as small as possible but they do not give definite limits of oxygen content.

Investigations on the effect of oxygen content in steel on its quality do not give an answer to the basic problem: whether it is necessary to aim at a minimum possible oxygen content in mild rimmed steel or whether there are some optimum permissible limits of its content.

A special investigation was carried out at one of the metallurgical works, with the object of solving this problem.

Steel 08kp was made in 185-t stationary open-hearth furnaces operating on liquid pig iron and fired with mixed gas. Steel was bottom-poured into ingots of 6 to 12 t. The technological instructions on the manufacture of this steel were in conformity with the basis clauses of the standard instructions issued by the Ministry of Ferrous Metallurgy USSR for the manufacture of rimmed steel.

In order to establish the effect of the oxygen content on the ductility of cold-rolled plate, 53 heats, carried out strictly in accordance with the technological instructions, were studied. Samples were taken from the molds midway through the pouring of each of those heats, and the oxygen content was determined by the aluminum method.

The results are given in Table 1.

TABLE 1

Dependence of the Ductility of Steel on Oxygen Content

Oxygen content in steel, %	Number of heats which passed ductility tests, group VG, %					mean ductility, %
	100	90-99	80-89	70-79	less than 70	
0.031—0.035	7	3	—	1	—	97.7
0.036—0.040	10	3	—	1	—	99.1
0.041—0.045	11	3	—	—	—	98.4
0.046—0.050	4	1	1	—	—	96.3
0.051—0.056	6	2	—	—	—	98.4

It is seen from the data in Table 1 that the best results on the ductility of steel are obtained at an optimum oxygen content, in this case equal to 0.036-0.040%. On the deviation of the oxygen content either above or

below these limits the quality of the metal is impaired.

In order to determine the effect of the oxygen content in steel on the tendency to seam formation, 54 heats of steel 08kp were studied. The tendency to seam formation was determined on the samples taken from each batch and subjected to a tensile test. Investigation showed that a minimum faulty material on account of seam formation is achieved when the oxygen content in steel is within the limits 0.031-0.040%. Deviations from these values, either above or below, increase the tendency of metal to seam formation.

36 heats were investigated with the object of determining the effect of oxygen content in steel on the tendency to aging. The tendency of steel to aging was determined on samples taken from cold-rolled plate.

The samples were tested for ductility after 45 days exposure at room temperature. The reduction in the depth of the depression after the exposure was taken as the criterion of aging effect. The results obtained are given in Table 2.

TABLE 2

Effect of Oxygen Content in Steel on Aging

Oxygen content in steel before deoxidation, %	Lowering of ductility after aging, %	Number of heats
0.032—0.040	3.23	3
0.042—0.052	3.15	12
0.056—0.066	2.74	16
0.070—0.080	3.5	5

The analysis of the heats investigated indicates that on increasing oxygen content in steel from 0.042-0.052% to 0.056-0.066% the ductility of steel after aging is reduced. A minimum reduction of the ductility corresponds to oxygen content in steel before the deoxidation within the limits of 0.056-0.066%. A further increase of the oxygen content in steel causes a fall in ductility after a true aging.

These data on the dependence of the aging effect on the oxygen content in steel qualitatively confirm the results, obtained earlier, on the dependence of the ductility of steel on the oxygen content.

In order to establish the dependence of the porosity of ingots on the amount of oxygen in steel, 140 heats were investigated. Oxygen content in the steel in 75 heats was determined on samples taken from the furnace before ferromanganese was added, and in 65 heats – on samples taken during pouring. The porosity of ingots was evaluated in marks according to the scale in use at the works. It was established that, other conditions being equal, the porosity of ingots increases with increasing oxygen content. This conclusion is rather approximate and should be confirmed by a separate investigation.

During hot rolling on the continuous thin sheet mill, it was found that, with an increase of the oxygen content in steel and at a high gas saturation, the amount of sheets with ragged flange increases.

Tests on steel samples taken from the investigated heats showed that with the decrease of oxygen content in mild rimmed steel the amount of non-metallic inclusions in steel decreases correspondingly (especially those of mark 3-5) and the structure of the metal improves.

STEEL MELTING PRODUCTION

From the Proceedings of the All-Union Conference of Steel Melters

APPLICATION OF SINTER IN OPEN-HEARTH MELTING

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In connection with the shortage of open-hearth ore, since February, 1955 the Combine has been using open-hearth sinter instead of ore for charging the open-hearth furnaces. According to the amount of ore available at the Combine, it is replaced either fully or partly by sinter. Thus, for 10 months in 1956, the average consumption of sinter has been 66.2% of the total consumption of oxidizing material.

Sinter is used in melting steel of all kinds, rimming steels, killed steels, carbon steels and alloy steels, in 140, 260 and 380 ton furnaces with Dinas and magnesite-chrome roofs. The furnaces are heated with a mixture of blast furnace and coke-oven gas with addition of tar for luminosity; some of them operate with oxygen-enriched flame.

The oxide ore is supplied to the works by the Goroblagodat Ore Control. The following chemical composition of the sinter has been fixed in accordance with the technical conditions: not less than 57.7% Fe, not more than 24.0% FeO, not more than 9.0% SiO_2, not more than 0.12% S, not more than 0.08% P.

Table 1 shows that the sinter differs from the ore in chemical composition by a higher content of ferrous oxide, sulfur and silica. The sinter contains less oxygen and therefore its oxidizing capacity is less than that of the ore.

The following data characterize the physical properties of the sinter: bulk weight (apparent) varies within the limits 2.7-3.5 g/cm^3, yield of fraction coarser than 25 mm in the drum test is 70-76% (for Magnitogorsk ore, the yield of this fraction is more than 80%; the bulk weight of the ore is 3.5-4.0 g/cm^3).

TABLE 1

Percentage Chemical Composition of Sinter and Ore

	Fe	FeO	Fe_2O_3	S	P	Mn	SiO_2	CaO	MgO	Al_2O_3	Oxygen content	Relative oxidizing capacity
Sinter	58.6	19.2	62.6	0.15	0.047	0.82	7.6	3.82	1.60	3.35	23.2	0.91
Magnitogorsk ore	60.6	8.1	78.0	0.04	0.032	0.15	6.8	6.59	0.42	2.84	25.5	1.00

The sinter arrives at the Combine with a 6-7% content of fraction below 10 mm, but becomes crushed in the unloading process and before being charged into the furnace contains up to 25% of fines below 10 mm (for good lump ore, the fines content before charging into the furnace did not exceed 20%). Thus, in physical properties, the open-hearth sinter is somewhat inferior to good lump ore, but the difference between them is not great and is not felt in practice, since the open-hearth shop often uses low-grade ores, including washed ores containing not more than 30% of the fraction above 25 mm.

In using sinter for open-hearth melting, the following routine has been adopted for charging free-flowing material. Two boxes of sinter are charged on the bottom through each door, then lime, the remainder sinter and ore.

This charging routine eliminates the possibility of explosions in the furnace and ejection of metal and

slag on to the working platform during the melting process, since the sinter always goes in dry. In addition, when the sinter is charged on the bottom, the loss of sinter in the slag is less.

Each charged layer is heated, but when using sinter the total charging period is reduced by 15 minutes, since a sinter layer heats up more quickly than an ore layer.

After running off the melt the tap hole is dried up with sinter; this operation, like that of charging the sinter on to the bottom, always proceeds quietly without explosions.

With the object of generalizing the experience in using sinter in open-hearth furnaces, a statistical study has been made of a large number of melts of current production, and two groups of experimental melts have been made with partial or complete replacement of ore by sinter. Table 2 gives the results of the statistical study. The results of the experimental melts are in agreement with the results of the statistical study and permit the following conclusions to be made.

1. Other conditions remaining the same, sinter consumption is higher than ore consumption. Thus, for rail steel, with full replacement of ore, sinter consumption in the charge is 8% higher than ore consumption, and for tube steel it is 10% higher.

2. The quantity of slag run off in charges using sinter is greater than in the case of ore melts. Furthermore, the quantity of slag removed increases with increase in the amount of sinter in the charge.

Intensive slag formation on melts with sinter begins earlier and the period of vigorous slag removal is shorter than in the case of melts with ore.

3. When sinter is used in the charge, due to its fusibility, the length of the melting period is reduced by 12-15 mins. per melt.

4. Use of sinter increases the ferrous oxide content of slag after melting.

5. With practically the same phosphorus content in the pig, the phosphorus content in the metal after melting with the use of sinter is less than in melts using ore (by 0.002-0.012%); the reduction in phosphorus content is proportional to the amount of sinter in the charge.

As the proportion of sinter in the charge increases, the phosphorus content in the slag after melting diminishes. The phosphorus content of the final metal of melts with sinter is also lower than in the metal of melts with ore.

Due to the lower melting point of sinter in comparison with ore, the slags of sinter melts become high in ferrous oxide earlier, i.e., in these melts active iron slags are formed earlier, which accelerates the oxidation of phosphorus and its transfer from the metal to the slag. The instant of maximum phosphorus content in slags of sinter melts is usually earlier than with ore melts, and therefore the P_2O_5 content in sinter melts towards the commencement of intense slagging is higher than with ore melts. In view, however, of the earlier vigorous formation of high-phosphorus slag of sinter melts, the P_2O_5 content drops, and this occurs earlier and more abruptly than with ore melts. In working with sinter, intensive slag formation commences 15-20 min. earlier than in working with ore.

In addition, the amount of slag run off in the first case (sinter melts) is greater and therefore, at the moment of complete melting, the P_2O_5 content of the slag and the phosphorus in the metal in these melts is lower than in melts using ore, even with the higher phosphorus content in the pig of the sinter melts.

The conditions for improved dephosphorization of the metal are thus more favorable when using sinter, from the point of view of both the temperature conditions and the activity and removal of the slag.

6. Due to the production of more oxidized slags after melting, the ore consumption in refining is reduced. The lower phosphorus content in metal and slag after melting and the lower ore consumption when using sinter in the charge reduces the lime consumption in the working up period, which in its turn results in lower bauxite consumption.

7. In sinter melts, the rate of removal of carbon in the ore boiling period is increased and the refining period is shortened. This is due to the better heating of the metal during the melting of the charge, associated with the production of a smaller quantity of slags which are also more fluid, as well as with the lower lime consumption during the refining period than with ore melts.

TABLE 2

Average Melting Parameters Obtained in the Statistical Study

Parameter	Working without sinter		Working with sinter	
	Steel			
	rail	10 ton	rail	10 ton
Number of melts	49	46	43	50
Consumption in charge, ton:				
Ore	45.8	16.1	5.7	—
Sinter	—	—	44.1	17.7
Pig	255.0	97.4	253.2	94.0
Scrap	124.0	41.6	123.0	46.5
Limestone	19.6	8.8	18.7	9.3
Bauxite	2.0	—	1.6	—
Content in pig, %				
Si	0.70	0.71	0.69	0.70
P	0.23	0.20	0.23	0.20
S	0.052	0.047	0.050	0.051
Duration of periods, hours-minutes:				
Fettling	0—33	0—24	0—34	0—30
Charging	2—02	1—14	2—05	1—21
Heating	1—30	1—24	1—50	1—14
Melting	4—09	3—06	3—57	3—00
Ore boiling	1—35	1—28	1—17	0—59
Final boil	0—59	1—12	1—03	1—06
Quantity of slag run off during melting period, ladles	2.46	0.77	2.61	0.80
Content in metal, after melting, %				
C	1.18	0.86	1.23	0.88
P	0.029	0.020	0.017	0.018
S	0.044	0.044	0.043	0.045
Content in slag, after melting, %				
P	0.81	0.97	0.69	0.77
FeO	8.11	10.10	9.80	11.95
Basicity of slag	2.0	2.2	2.1	2.0
Consumption in refining period, tons:				
Ore	7.8	4.0	7.0	3.2
Lime	4.3	1.9	3.4	1.2
Bauxite	1.5	0.2	0.5	0.1
Rate of removal of carbon during boiling period, %C/hour:				
Ore boiling	0.28	0.48	0.35	0.57
Final boiling	0.16	0.23	0.18	0.24
Phosphorus content of final metal, %	0.027	0.022	0.022	0.022

Investigations have shown that the use of sinter in the charge does not impair the quality of the steel.

From observations which have been made, the condition of the sides at the level of the slag zone and bottom is not impaired by using sinter. This is confirmed by the fact that the consumption of powdered magnesite for fettling the furnaces did not increase in the period during which sinter was used. Thus, in 1954, when open-hearth shop No. 1 was working on ore alone, without the use of oxygen, the consumption of powdered magnesite was 17.5 kg/ton of steel, and in 1956 (11 months), when the shop began to work on sinter with the use of oxygen, the consumption of powdered magnesite was 17.7 kg/ton.

In the great majority of melts with sinter in the charge, for the same weight of metal portion of the charge, the average weight of the melt is somewhat greater than that of melts with ore. This is due partly to the introduction of a larger amount of iron into the bath in connection with the higher sinter consumption, less oxidation

of iron due to the shortening of the melting period, and also the steady, intense melting without iron being thrown out over the sills and through the slag holes in the back.

Experimental melts carried out with the addition of sinter instead of ore in refining have shown that, due to its lower specific gravity and higher fines content than ore, sinter is held in larger amounts in the slag and enters into reaction with the carbon much later. This creates difficulties in controlling the process. Furthermore, the addition of sinter increases the foaming or frothing of the slags. Sinter is very rarely used, therefore, at the Combine in the refining period.

THIN-WALLED INGOT MOULDS FOR CASTING KILLED STEEL

Engineer A. M. Danilov

(Zlatoust Metallurgical Works)

For casting ingots of killed steel, the moulds usually employed widen towards the top, the wall thickness at the bottom being much greater than at the top.

Steel melters hold different views about the effect of the wall thickness of the mould on the crystallization and quality of the steel ingot.

Some authors consider it useful to have thicker ingot walls; others, on the contrary, assert that reduction in thickness of the walls has a favorable effect on the structure of the steel ingot; finally, there is the veiw that the thickness of the wall (in the usual limits) has no appreciable effect on the progress of crystallization, shrinkage and segregation in the ingot.

An investigation has been carried out at the Zlatoust Metallurgical Works into the effect of the wall thickness of the mould on the structure and quality of an ingot of alloy steel. For this purpose 3.6 ton open hearth alloy steel ingots were investigated, these being cast in moulds, the walls of which were 70 and 140 mm thick and which were produced by displacement of the cores in making the moulds used for casting the ingot moulds. Fractures of these ingots failed to reveal any appreciable differences in crystalline structure.

3.6 ton ingots were then teemed in thin-walled ingot moulds, the thickness of the wall being the same throughout the height of the mould. In these ingots also, no chemical inhomogeneity was found.

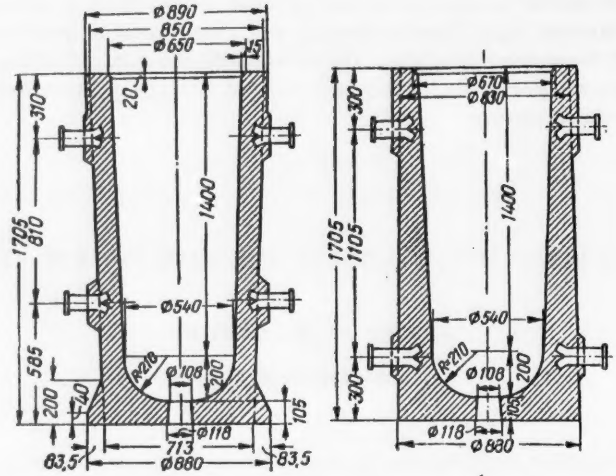
After preliminary experiments in open hearth shop No. 2, an extensive examination was made to see whether it would be possible to use thin-walled ingot moulds for casting ingots of high-quality carbon steel and alloy steel.

In the shop, the steel is cast on bogies by bottom pouring in square ingots weighing 4.6 tons, the length of side of the top section being 650 mm.

The wall of the new ingot mould has the same thickness throughout the entire height (see Figure). For strengthening the mould and preventing its displacement when pouring, ribs are provided at the lower end. To increase the life of the mould, the thickness of the ribs at the trunnions has been increased, the end of the trunnion being at such a distance from the inner surface of the mould as to reduce bitting and cracking in the vicinity of the trunnions during service. Details of the thin-walled ingot mould and an ordinary mould are compared in the Table.

As will be seen from the Table, the ingot mould is 1.1 ton lighter than the ordinary mould. Investigation has shown that thin-walled ingot moulds have a life of an average of 44.8 castings and ordinary moulds one of 40.5 castings. Thus, the life of thin-walled ingot moulds is 4.3 castings longer. This is due to the more even heating of the wall in the vertical direction after casting the ingot.

Ingot moulds of both types were rendered unfit for further service mainly due to longitudinal cracks (63-64%), blisters (25-27%) and pitting and cracking (11-12%).



a b

Form and basic dimensions of ingot moulds for 4.6 ton ingots.
a) thin-walled mould; b) ordinary mould.

For studying the structure of the steel, two ingots of 18 KhGT steel were bottom cast simultaneously, one in a thin-walled ingot mould and the other in an ordinary ingot mould. The crystalline structure, density and segregation were identical in both cases.

Large-scale application of thin-walled ingot moulds has confirmed the character of steel cast in thin-walled and ordinary ingot moulds. The results of a check of 213 melts cast in thin walled ingot moulds and 257 melts cast in ordinary ingot moulds showed that from the degree of development of shrinkage central and total porosity and the occurrence of defects in the macrostructure, the quality of the steel does not depend upon the type of ingot mould.

The introduction of thin-walled ingot moulds results in a considerable saving: the consumption of ingot moulds has dropped from 22.3 (for ordinary ingot moulds) to 17 kg/ton, i.e., by 23.8%.

Parameter	Ingot moulds	
	Thin-walled	Ordinary
Weight of ingot with dead head, tons	4.6	4.6
Weight of ingot mould, tons	3.8	4.9
Ratio of weight of ingot mould to weight of ingot (without dead head)	1.01	1.03
Thickness of ingot wall, mm:		
Top	100	90
Bottom	100	170

It is clear from the study made that for a large ingot, the thickness of the mould wall has no effect on the crystallization of the ingot or on the quality characteristics and defects of the steel, but should be determined mainly by the mechanical strength of the ingot mould.

FETTLING THE BOTTOM AND SIDES OF ELECTRIC FURNACES WITH FINE CHROME ORES

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(Kuznetsk Metallurgical Combine)

The melting of stainless steel on scrap with oxygen-blowing in a 30 ton basic electric arc furnace gives rise to special conditions regarding the maintenance of the lining.

Due to the shortening of the melting period, the life of walls and roof is increased. On the other hand, heating of the metal and slag to high temperatures (1850°C), due to oxygen blowing, results in a considerable reduction in the life of the bottom and sides of the furnace. This is also assisted by the reaction between slag and lining, the result of which is that the lining becomes saturated with oxides of iron and its refractory properties are greatly diminished.

The unsatisfactory life of bottom and sides causes considerable difficulties in the production of stainless steel. The time spent on fettling is much greater than when melting other steels. Thus, for example, the average fettling time for 508 melts of stainless steel for the period January – July, 1955 was 26 minutes. For the same period, the fettling time when melting other steels (structural steels, ShKh15) was 19 minutes for 550 melts. When melting stainless steel, the fettling time was increased by more than 37%, and three times as much material was used for fettling than when melting other steels.

Despite the increased consumption of fettling materials and the longer and more careful fettling, it was difficult to maintain the bottom and sides in normal condition when melting stainless steel. As the furnace run continued, the condition of the bottom and sides became worse from one melt to the next, and after several melts it was necessary to interrupt the melting of stainless steel and to continue with the melting of other steels in order to strengthen the lining. Such interruptions were formerly made after every 10 to 15 melts. When the sides collapsed the furnace was laid off for extensive cold repairs, the lining of the sides being renewed to the extent of from 40 to 80%.

In recent years, the shop has made improvements in the technology of stainless steel melting, and these have eased the service conditions of the lining of bottom and sides. It has been possible to reduce the time of oxygen blow by an average of 15 min. by blowing through two lances at once, to reduce the bath temperature after blowing by adding up to 1.5 tons of slab to the metal and to reduce the refining period by 20 mins. Despite the considerable reduction in the duration of the destructive action exerted by the superheated metal and slag on the lining, however, there was no significant improvement in the life of the bottom and sides.

Several modifications were tried in fettling the bottom and sides with different combinations of a mixture of powdered magnesite and burnt ferruginous dolomite in different particle compositions. This did not, however, result in any increase in the life of the furnace lining.

At the suggestion of the workers of the electric steel-melting shop Monastyrsky, Glazov and Kibenko, fine chrome ore was introduced into the mixture used for fettling the electric furnace lining when melting stainless steels. This suggestion was based on the following:

1. Working experience of the shop showed that chrome ore has a favorable influence on the condition of the bottom. According to technological instructions, chrome ore was introduced into the charge with the object of reducing the loss of chromium in the middle of the bed of charge. In a number of cases, where there were depressions and holes on the bottom, pieces of chrome ore had fallen on to the bottom. As a rule, when this happened, the bottom improved and the holes disappeared.

2. It is well known that chrome-magnesite and magnesite-chromite refractories, which contain chrome ore in their composition, used for lining the walls, roof and bottom, possess high durability.

3. According to the literature, some American works use chromite bottoms when melting very low carbon

stainless steels. When such bottoms are used, however, the qualities of the steels melted are confined to those containing not less than 5% chromium.

Considering these facts we endeavoured to increase the life of the bottom and sides by using chrome ore in the fettling mixture, while retaining the possibility of melting in the same furnace other kinds of steel, independently of their chromium content. This problem was solved successfully by using a fettling mixture consisting of 30-40% powdered magnesite, 20-30% burnt ferruginous dolomite and 40% fine chrome ore.

TABLE 1

Characteristics of Constituents in Fettling Mixture

Constituents	Quantity, %	Fractional composition, mm	Chemical composition, %				
			MgO	CaO	SiO_2	$Al_2O_3+Fe_2O_3$	Cr_2O_3
Powdered magnesite MPMZ	30	0—4 mm (not less than 95%)	88	3	5	—	—
Burnt ferruginous dolomite	30	1—7	28	—	5	8	—
Chrome ore	40	—	—	—	7	15	50

TABLE 2

Technical and Economical Factors of the Adoption of Chrome Ore

Constituents	Consumption of material kg/ton		Saving %
	before adoption	after adoption	
Powdered magnesite	20.5	17.5	14.6
Burnt ferruginous dolomite	15.9	13.8	13.3
Fine chrome ore	—	2.5	—

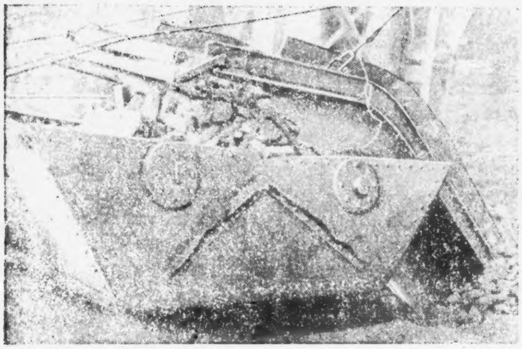
Table 1 shows the composition of the refractory materials used at the present time in the fettling mixture for melting stainless steel.

A new technique for fettling the electric furnaces has been evolved. Before beginning the stainless steel furnace campaign, the bottom and sides are covered with a thin layer of fine chrome ore, which satisfactorily protects the lining from attack by the metal and slag. On the succeeding melts, the bottom and sides are as a rule in satisfactory condition, but to prevent the formation of holes in the bottom and wear of the sides, the furnace lining is repaired (fettled) after each melt with a thin layer of the fettling mixture.

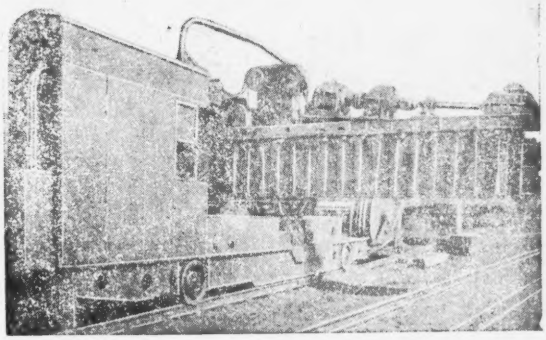
The result of introducing the new fettling method from August, 1955, has been a marked improvement in the furnace lining condition. Thus, before the introduction of the new fettling method, the life of the bottom from repair to repair was 838 melts, but now the life of the bottom reaches 2000 melts. The life of the walls has increased by 10%. With the new fettling method, there has been a considerable economy in fettling materials and it has been found possible to melt stainless steels without interruption. Table 2 shows the technical and economic factors of the effectiveness of using chrome ore for fettling furnace linings.

The annual saving in the electric steel melting shop of the Kuznetsk Metallurgical Combine for fettling materials alone is about 100,000 roubles.

MECHANIZATION OF LOADING AND UNLOADING AT THE KUZNETSK METALLURGICAL COMBINE



Scraper equipment for removing slag and loose bricks from slag ladles.



Machine with vertical scrapers for unloading loose materials from railroad flatcars.

ROLLED MATERIAL AND TUBE PRODUCTION

INCREASING THE PRODUCTIVITY OF A SHEET MILL

Cand. Tech. Sciences A. A. Nefedov (Ural Ferrous Metals Institute), Eng. G. Z. Shcherbina

(Central Works Laboratory, Enakiev Metallurgical Works)

At the Enakiev works, sheet is rolled on a double-stand two-high mill with rolls 700 mm in diameter, roll body length 1700 mm in the first stand and 1500 mm in the second. Both rolls are driven and are water-cooled. The sheet is rolled from bars, heated in two double zone, single row continuous furnaces.

The thickness of the sheet produced is 2.0, 2.5 and 3.0 mm, the width up to 1400 mm. Sheet with the dimensions 710 × 1420 mm constituted about 30% of the total output, one sheet being rolled from one bar. This non-rational utilization of the working length of the roll body resulted in a marked reduction in the productivity of the mill. To increase it, the proposal was made to roll these sheets to a width of 1420 mm, and to make the length equal to three times the width of an ordinary sheet, i.e., 2130 mm. After shearing, three sheets of the dimensions 710 × 1420 mm are obtained (Fig. 1). With this method of rolling, the productivity of the mill was increased and waste of metal diminished, due to the reduction in the relative amount of trimming waste.

With the technical conditions operative at the works, the permissible deviations in thickness of the sheets are shown by the values given in Table 1.

Increasing the sheet width to 1420 mm, however, did not justify the utilization of an increased plus tolerance, since in rolling, the width became the length after cutting up the sheet. This led to a narrowing of the plus tolerance range by 16.7% for sheets 2.0 mm thick, by 20% for 2.5 mm sheets and by 22.7% for 3.0 mm sheets. When this method of rolling was adopted, difficulties therefore arose in connection with the necessity

to reduce the transverse and longitudinal differences in thickness.

It is well known that the cause of the transverse variation in thickness is mainly the springing of the rolls, due to the pressure of the metal during rolling, in consequence of which the thickness of the sheet in the middle part is greater than at the edges. To prevent this occurrence, sheet mill rolls are made convex, the convexity being equal to the amount of spring of the roll in operation.

TABLE 1

Sheet width, mm	Sheet thickness, mm		
	2.0	2.5	3.0
Up to 1000	+0.15	+0.16	+0.17
	−0.18	−0.20	−0.22
Above 1000	+0.18	+0.20	+0.22
	−0.18	−0.20	−0.22

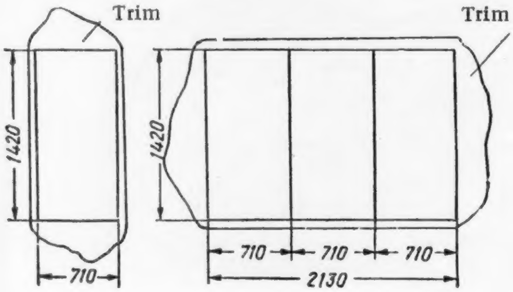


Fig. 1. Rolling and lay-out diagram for sheets.

The results of rolling several experimental batches indicated that a considerable number of sheets (from 4.3 to 5.7%) were transferred to second quality as being thin.

Measurements showed that the outside panels of the rolled piece were usually thin while the middle panel, as a rule, was within the tolerances. This is related to the longitudinal difference in thickness, the cause of which lies in the uneveness of the resistance of the metal to deformation along the length to the sheet. The chief factor in the resistance of the metal to plastic deformation is the rolling temperature. The more uneven is the reheating, the more uneven also is the resistance of the metal to deformation and the greater the longitudinal difference in thickness. The most radical means of reducing the longitudinal difference in thickness is therefore to reduce the uneveness of reheating, which in its turn has less effect on the variation in thickness, the higher the rolling temperature.

In investigating these relationships, the following were determined: reheat temperature of every fifteenth bar after the first pass, air and gas consumption of the furnace and thickness of each panel at six points. Fig. 2 shows the character of longitudinal difference in thickness when rolling 3.0 mm sheet. The pieces after the first pass had the following temperature: first – 1130°C, second – 1130°C, third – 1090°C, fourth – 1140°C, fifth – 1110°C, sixth – 1085°C and seventh – 1110°C. When double rolling to a thickness of 2.0 mm, the temperature of the top piece only was measured. In Fig. 3, these pieces are denoted by primed numbers: 6' – 1110°C, 7' – 1080°C, 8' – 1140°C, 9' – 1130°C.

TABLE 2

Size of sheet, mm	No. of sheets examined	1st Quality	2nd Quality			Cut up		
			flaws	thickness variation	thin sheets	scale	narrow sheets	short sheets
3×710×1420	1503	1395	6	28	48	11	9	6
%	100.0	92.8	0.4	1.86	3.2	0.74	0.6	0.4
2×710×1420	1715	1600	5	43	46	9	5	7
%	100.0	93.4	0.3	2.5	2.6	0.5	0.3	0.4

Despite the complicated nature of the curves of the variation in longitudinal difference in thickness, they show sufficiently clearly the way in which this difference depends upon the rolling temperature. The values of the thickness difference fluctuate within wide limits from 0 to 0.39 mm, and therefore the probability of the thickness of the sheets being outside the tolerance limits is fairly high (+0.15; −0.18 mm for 2.0 mm sheets; and +0.17; −0.22 mm for 3.0 mm sheets). The temperature of the pieces was normally not measured during rolling, and therefore the relationship was ascertained between the thickness deviation and the main working factors of the reheating furnace, primarily the ratio of air and gas. Investigation showed that the furnace operates with a considerable deficiency of air in the welding zone. Increasing the supply of air intensifies combustion in the welding zone, results in an increase in the reheating temperature of the bars and consequently in a reduction of the longitudinal thickness difference.

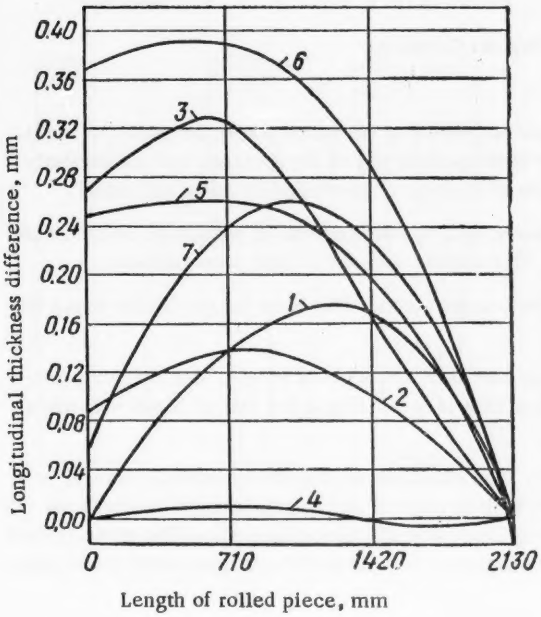


Fig. 2. Longitudinal thickness difference when rolling 3.0 mm thick sheets.

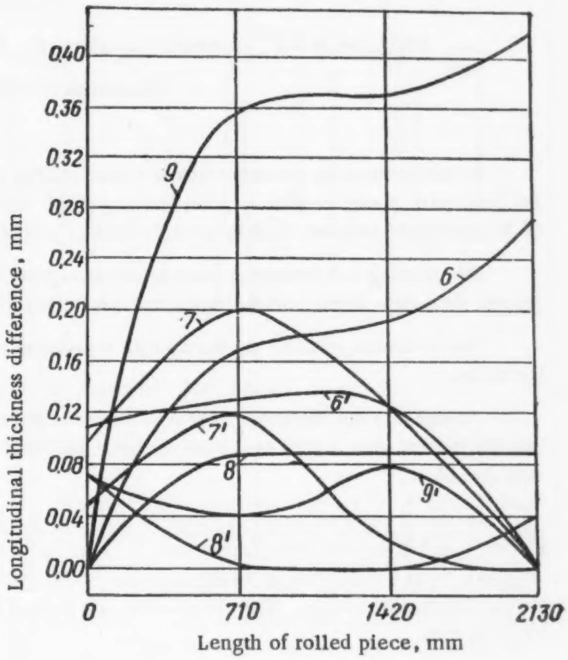


Fig. 3. Longitudinal thickness difference when rolling 2.0 mm thick sheets.

TABLE 3

Size of sheet, mm	Productivity, tons using old method	Productivity, tons using new method	Increase in productivity, %	Trimming scrap, % using old method	Trimming scrap, % using new method	Reduction in shear scrap, %
2×710×1420	17.2	27.7	61.3	8.86	4.85	45.7
2.5×710×1420	19.0	32.25	69.7	8.85	4.85	45.6
3.0×710×1420	24.3	34.6	42.5	8.85	4.92	44.4

Changing over the furnace to working with an increased air supply in the limits of 3.66 – 3.74 m^3 of air to 1 m^3 of gas resulted in an increase in the production of first quality sheets (Table 2).

As a result, the output of first quality sheets in 592 tons of rolled sheets was 92.9% for a usual 91%.

The increase in the mean shift productivity of the mill is shown in Table 3.

When rolling 710 × 1420 mm sheets by the new method, the productivity of the mill increased by 40 – 70%, the consumption of steel was reduced due to the reduction in shear scrap, and it was found possible to roll to severer plus tolerances.

SELECTION OF A RATIONAL PNEUMATIC STEEL-DRESSING TOOL

Engineers N. V. Amchislavsky, R. A. Braunshtein and M. S. Shlionsky

(Kuznetsk Metallurgical Combine)

In the pneumatic dressing of steel before rolling and for trimming the rolled piece, the principal tool is the pneumatic hammer with a chisel working in it. The labor productivity of the operators and consequently of the entire job depends largely upon the proper selection of the type of pneumatic hammer and chisel.

For dressing and trimming steel at metallurgical works, various combinations of pneumatic hammers and chisels are used. These combinations are numerous and often depend upon accidental circumstances.

The hammers used for the pneumatic dressing of steel at the present time have the particulars shown in the table.

As will be seen from this table, the power of the hammer increases with its weight. Some experts mistakenly believe that a high rate of blows with less work per blow is better than a low rate of blows with more work per blow.

Different types of chisel are used at different works. The chisel shanks may be cylindrical, conical or of the form of a truncated hexagonal pyramid (Fig. 1). The cutting edges of the chisels have widely differing contours, from a symmetrical wedge to a one-sided cutting edge (Fig. 2). The chisels also differ in shank diameter, length and weight. The chisel edges are ground to angles of from 40 to 85° and their width varies from 12 to 60 mm.

Type of hammer	Air		Work of blow, kgm	No. of blows per min.	Hammer power, H.P.	Weight of head, kg	Length of hammer, mm	Total weight of hammer kg
	pressure, atm. gage	consumption, m^3/min						
RB-54		0.5—0.6	1.9	1500	0.65	0.40	340	5.4
RB-58		0.5—0.6	2.5	1250	0.70	0.47	380	5.8
RB-63		0.5—0.6	2.6	1100	0.70	0.54	410	6.3
KE-16	5—6	1.0—1.1	2.1	1800	0.84	0.40	310	8.0
KE-19		1.0—1.1	2.7	1400	0.85	0.45	360	9.0
KE-22		1.0—1.1	3.4	1100	0.88	0.55	410	9.5
KE-28		1.0—1.1	4.4	900	0.91	0.60	460	11.0
KE-32		1.0—1.1	5.8	800	0.94	0.65	510	12.0

Such prolific variation in the characteristics of steel dressing tools has a profound effect on the labor productivity of the operators.

With a view to elucidating the effect of the various characteristics of hammers and chisels on the labor productivity of operators, and investigation was made at the Kuznetsk Metallurgical Combine. Its object was to elucidate the effect of characteristics such as the type of hammer, weight of chisel, width of its edge and grinding angle on labor productivity.

Chisels of seven weight categories were made (1000, 1250, 1500, 1750, 2000, 2250 and 2500 grams). Each category was represented by chisels with a width of edge of 15, 20, 25 and 30 mm, ground at an angle of 45, 55, 65 and 75°.

Slabs rolled from St 3 steel from the same melt were dressed.

A track 500 mm long was marked out on each slab. The chip removed from this track was weighed. The time taken to remove the chippings was also determined.

The tests were carried out by one of the most skilled operators of the Combine for identical pressure conditions of the air supplied to the hammer. The coefficient of productivity was the weight in grams of chip removed in unit time.

Three chips were taken for each chisel and hammer tested. All the chisels were made of 6KhS steel, the hardness of the edge was the same (57 R_c).

The results were collected in tables, from which the mean coefficients were calculated for each type of hammer and each type of chisel. Diagrams of the more indicative characteristics were drawn up on the basis of the data obtained. About 2500 measurements were made.

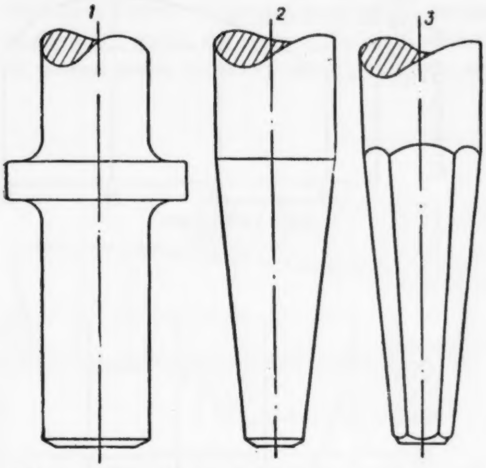


Fig. 1. Forms of chisel shank:
1) cylindrical; 2) conical; 3) truncated hexagonal pyramid.

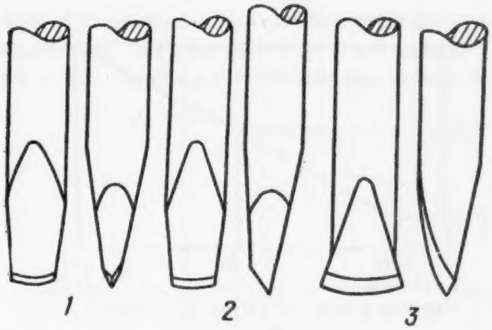


Fig. 2. Forms of chisel edges.
1) symmetrical wedge; 2) unsymmetrical wedge; 3) one-sided cutting edge.

Figure 3a is a diagram showing the dependence of labor productivity of the operator upon the type of hammer used for steel dressing. As will be seen from this diagram, productivity increases with increase in power of the hammer. This confirms the fallibility of the view that a high frequency or rate of blows is advantageous for metal dressing.

It may thus be concluded that in selecting the type of hammer, it is necessary to be guided first of all by its power, since the air consumption of hammers of different types is practically the same. We recommend the use of two types of hammer – KE-22 and KE-28, and for dressing ingots and blooms of large cross-section – hammer type KE-32.

Figure 3b shows the labor productivity of the operator versus grinding angle of chisel edge. As will be seen from the diagram, higher productivity is achieved with a more acute grinding angle of the edge (other things remaining the same). It is known from practice, however, that the life of the chisel is lessened by diminishing the grinding angle For soft steels, therefore, it is recommended that chisels with a grinding angle of from 40 – 50° should be used for medium hardness steels 50 – 60° and for hard steels 60 – 75°.

Figure 3c shows the way in which productivity depends upon the width of the chisel cutting edge. As will be seen from the diagram, productivity increases with increase in the width of edge from 15 to 23 mm. On further increase in the edge width, productivity falls off. Consequently, the optimum width of chisel edge must be considered to lie within the limits 20-23 mm. In practice, it has been established that for dressing single cracks and for dressing hard steels the blade must be in the range 15-22 mm; for dressing large surfaces affected by small defects and for dressing soft steels, the best edge width should be regarded as 18-30 mm. Analogous data were obtained when investigations were made at the Magnitogorsk Metallurgical Combine (in this investigation, the criteria taken were the width and depth of the groove left after the passage of the chisel and not the weight of the chips).

Figure 3d shows the dependence of productivity upon chisel weight. As will be seen from the diagram, productivity falls off sharply with increase in weight of chisel.

The conclusion may thus be made that even an insignificant reduction in weight of the chisel, other conditions remaining the same, will help in increasing the labor productivity. The weight of the chisel may be reduced by reducing the diameter of its shank, but if that is done it is impossible to avoid loss of power of the hammer due to loss of part of its energy in longitudinal bending of the chisel shank. The weight of the chisel may be reduced by reducing its length. This is the more correct way, but here again there are obstacles, although it is true they may be overcome.

When dressing steel, the operator holds the hammer in the right hand, and with the left he guides and

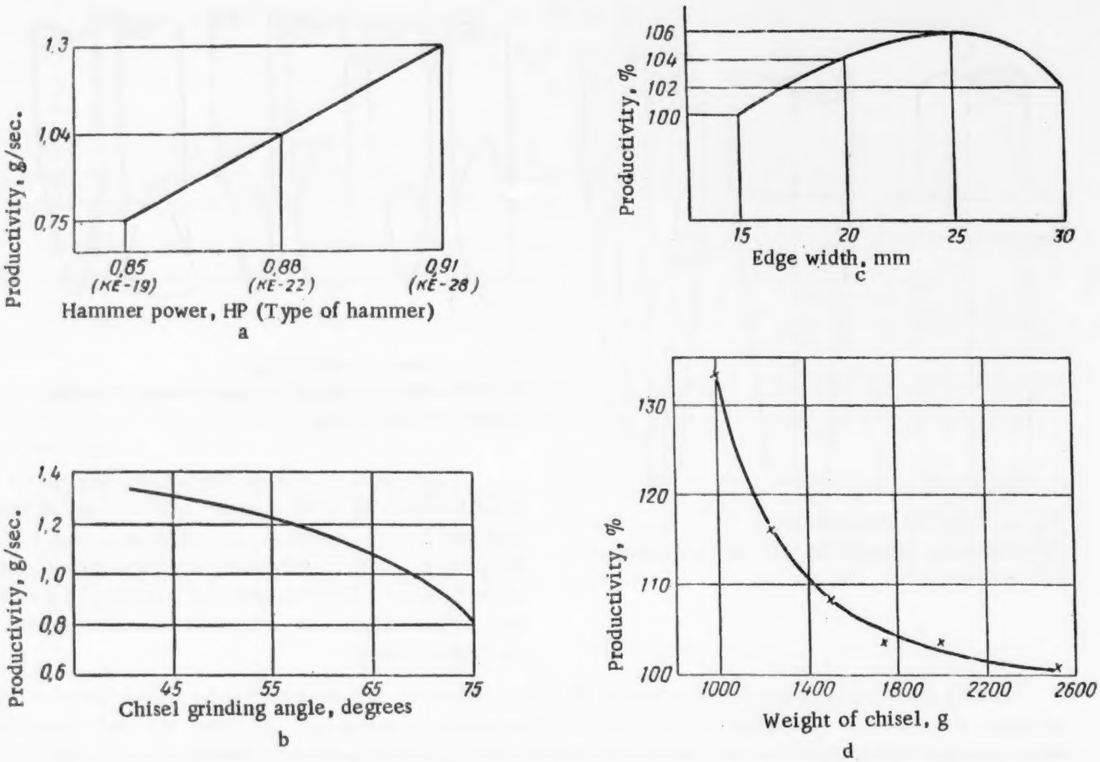


Fig. 3. Dependence of labor productivity of operators upon hammer power (a), grinding angle of chisel (b), edge width (c) and chisel weight (d).

rotates the chisel on its long axis, The necessity for holding the chisel in the hand permits the length of the chisel, and consequently its weight, to be reduced only to a certain limit. In addition, the steel is sometimes dressed "from the arm" which requires a minimum length of hammer and chisel, and sometimes "from the knee," when the length of hammer and chisel should be such as to ensure the possibility of using this highly productive method of working.

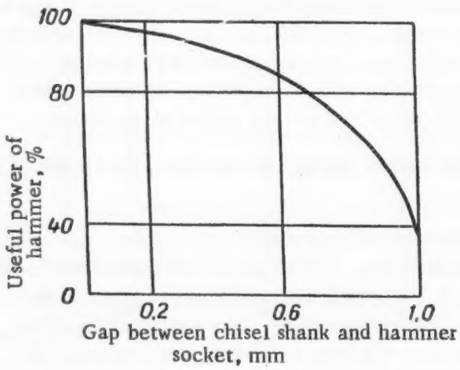


Fig. 4. Degree of utilization of hammer power versus size of gap between hammer socket and chisel shank.

Finally, the question as to the weight of the chisel cannot be solved independently without a correct solution of the problem of the shape of the chisel shank.

Of the three forms of chisel shank shown above (see Fig. 1), two exclude the possibility of turning the chisel during rotation of the hammer shaft. One shank only, in the form of a truncated hexagonal pyramid, permits rotation of the chisel on its longitudinal axis together with the hammer.

In selecting the form of chisel shank, it is necessary to be guided by the known condition which requires a close fit of the shank in the hammer socket during the entire operating time.

Figure 4 shows a plot of useful hammer power versus gap between hammer socket and chisel shank. As will be seen from the diagram, when the gap is 1 mm

the hammer power drops to 40%. It follows that the maximum effect will be provided by a shank, the shape of which ensures maximum utilization of hammer power.

At first sight, it would appear as if a shank in the form of a truncated cone would best meet the demands formulated above. A detailed study of this problem shows, however, that after each blow of the hammer head on the chisel shank, the latter is displaced relatively to the socket, forming a considerable gap, through which air escapes during the return stroke of the head (Fig. 5).

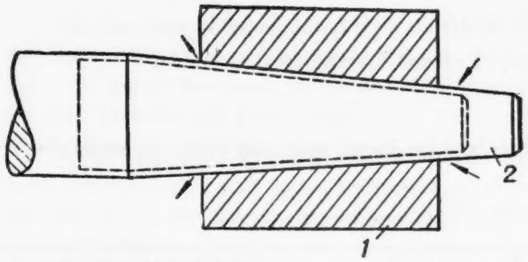


Fig. 5. Formation of gap between socket (1) and chisel shank (2) at the moment of impact of hammer head (arrows indicate the points of air escape from the hammer shaft).

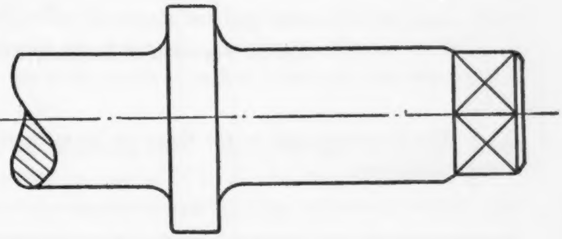


Fig. 6. Combined form of shank.

In practice, the shank in the form of a truncated hexagonal pyramid cannot be driven home to the faces of the socket, so that full utilization of the hammer is not obtained. A shank of cylindrical form fits the socket most closely, but in this case, the chisel does not rotate on rotation of the hammer.

Thus, in order to allow for the possibility of rotating the chisel with maximum tightness of fit of the shank in the socket, it is possible to recommend the use of a combined form of shank: a cylinder-square or cylinder-hexagon (Fig. 6). The cylindrical part of the shank is turned on a lathe and its square or hexagonal part is forged. The best weight of chisel is 600 – 900 grams.

For steel dressing, it is essential to employ pneumatic hammers of maximum permissible power. For dressing with tool supported on the arm, a hammer of type KE-22 may be recommended, with support on the knee KE-28, for heavier work KE-32.

PRODUCTION OF ROLLED MATERIAL AND TUBES

REDUCING THE CONSUMPTION OF BLOOMING MILL ROLLS

N. V. Slizen

(Senior Foreman of Roughing Mill Shop, Kuznetsk Metallurgical Combine)

The blooming mill of the Kuznetsk Metallurgical Combine has forged steel rolls of the following chemical composition:

Chemical composition, %						Mechanical properties	
C	Mn	Si	P	S	Cr	ultimate tensile strength kg/mm^2	relative elongation %
			not more than				
0.45-0.55	0.50-0.90	0.20-0.40	0.045	0.045	0.5-0.6	60-70	not less than 12

The necks of new sets of rolls are hardened to a depth of about 3.0 mm with a hardness of 340-380 H_B.

Over a number of years, the chemical composition of steel for rolls has remained the same, while the life of the rolls has increased, due to improvements in methods of rolling and heating the steel, and to an increase in the service life of roll collars and grooves. These steps have made it possible systematically to increase the life of the rolls, i.e., to reduce their consumption. The following figures relate to roll consumption in 1951-1956:

Year	1951	1952	1953	1954	1955	1956
Roll consumption, gram/ton of steel rolled	48.2	46.1	43.6	41.9	41.8	41.1

The blooming mill operates with considerable reductions per pass for low main motor speed. When rolling blooms of 320 × 330 mm from an ingot 705 × 795 mm in cross-section, the reductions in the first pass amount to an average of 70 mm, and in the final pass they attain 140 mm.

Large reductions increase the spread of the metal and also increase the work of the collars. More than 40% of the ingots are cast in moulds wider at the top than at the bottom and having ceramic feeder heads. When such ingots are rolled, the roll collars are subjected to considerable wear. The rolls have been lasting for 5 or 6 dressings and have then become useless.

At the present time, the collars are built up by welding. The passes are first of all cleaned by machining on a lathe and are then built up, using non-coated 30G steel electrodes of rectangular cross-section, 5 × 7 mm. A d.c. welding machine is used, employing reverse polarity. The mean current per electrode is 300-350 amp.

Rolls with built-up collars last up to 10 dressings; at each dressing, the roll diameter is reduced by 8-10 mm. When certain alloy steels are rolled, the rolls are not watercooled, which results in overheating of the bed and an increase in fire crazing. For the first few days after the rolls have been mounted in the housings and their surface is smooth, they have been observed to slip when gripping the piece.

To improve the bite and eliminate annular cracking, the bottom in all the passes has been ragged by means of specially made ragging tools of ShKh15 steel. Ragging has given positive results. Practically no slipping occurs when the piece is being gripped, particularly in the middle of the piece. There are no continuous annular cracks to be seen. After ragging was adopted, there were no cases of rolls breaking along the pass bottom.

The rolls run in textolite bearings. The lower bearings, which operate under heavier conditions, were usually replaced on account of wear each time the rolls were changed. Since chilling of the necks has been adopted, the wear on bearings is only 3 to 5 mm in a campaign.

The necks are flame hardened.

The hardness of the hardened layer should be the same over the entire working surface of the neck. There should be no bands having different hardnesses. With continued use of the rolls, the hardened layer becomes worn. To true up the necks, the residue of hardened layer has to be removed with a cutter and then the neck has to be hardened and ground again.

Since 1957, rolls of 60 KhN steel have been used on the blooming mill. During the first campaign, 54% more steel was rolled than during a campaign of average length on rolls of 50 steel. In 1956, rolls made of this steel on the average worked continuously for 285 hours between roll changing. The roll set of 60 KhN steel worked 437 hours.

At the present time, work is being done on building up the collars and bottom of the passes with hard alloys, and the change of material ought considerably to increase the life of the rolls.

CONFERENCE ON BUILD-UP WELDING OF PARTS OF METALLURGICAL EQUIPMENT

V. K. Petrichenko

(All-Union Scientific Research Institute for Ferrous Metallurgical Equipment)

At the commencement of this year, the Ministry of Ferrous Metallurgy of U.S.S.R., together with the E. O. Paton Institute of Electric Welding of the Academy of Sciences of the Ukrain.S.S.R. arranged a conference at which were represented concerns and scientific research and planning institutes of the Ministry of Ferrous Metallurgy of U.S.S.R. and Ukrain S.S.R.

The purpose of the conference was to acquaint workers in ferrous Metallurgical concerns with the experience of the scientific research institutes and advanced concerns in building up steel rolls and other parts of metallurgical equipment by machine welding, and to formulate proposals for the further development and extension of build-up by machine welding.

Representatives of the E. O. Paton Institute of Electric Welding informed delegates of their work on new methods of welding build-up. In the laboratories of the Institute, the delegates were shown machines for build-up welding of the centers of grab cranes, lathe centers and other parts, using an electrode of large cross-section; for building up crane wheels, rolls and other parts of a diameter greater than 700 mm by means of three electrodes at the same time (the productivity of such machines is two or three times higher than that of the A-384 machines employed at the present time); for build-up welding by means of a band 50-70 mm wide, used as electrode instead of a wire; for building up the collars of cogging and blooming mill rolls using the submerged arc welding process.

The first two of these machines can already be employed in industrial conditions, the third and fourth are in the experimental stage of prototype testing.

Papers were read at the Conference by members of the E. O. Paton Institute of Electric Welding, the All-Union Scientific Research Institute for Ferrous Metallurgical Equipment, the Zhdanov Metallurgical Institute and representatives of the Ministries for Ferrous Metallurgy of the U.S.S.R. and the Ukrain S.S.R.

Papers and communications of works representatives relating to experience gained in the use of machine welding build-up and the technical and economic results attained were accorded considerable interest.

Extensive works application has been made of welding build-up of steel rolls with wear-resistant steel, type 3Kh2V8, using powder wires.

Comrade Gorelov said that at the Voroshilov works, build-up welding is employed for the working rolls of the four-high stand of strip mill 2800. The life of the rolls for one mounting has been increased from 8 hours to 24. Built-up rolls can be ground better than ordinary rolls. The use of build-up welding has extricated the works from difficulties associated with a shortage of forged rolls. In the second half of 1956, the works effected savings amounting to 1.5 million rubles.

At the "Krasny Oktyabr" works, said Comrade Antonov, the rolls of roughing stands of mills 260, 325, 450 No. 1 and 2 have been built up since December, 1955; in some cases built up rolls are employed successfully instead of rolls of chilled cast iron (for example, in the 2nd stand of the 3rd train of mill 260 and the 3rd stand, 2nd train of mill 450, No. 1).

In 1956, the consumption of steel rolls was reduced by 140 in number (213.5 tons), due to the use of build-up welding at the works, the stoppages of mills for roll changing were reduced by 232 hours and an additional 5629 tons of serviceable rolled material was produced.

At the present time, a method is being worked out for build-up welding of passes of different forms, and the variety of built-up rolls is being extended.

At the Kuibyshev Kramatorsk metallurgical works (information given by Comrade Morozov) build-up welding of rolls has been used since January, 1955, in the 1st and 2nd stands of the roughing train of mill 280. The life of the rolls has been increased to 20 days, instead of 6. The mill stoppages have been reduced to 18 hours monthly and the consumption of rolls in these stands has been reduced 2.5 times. Build-up of box passes using 30KhGSA and PP-3Kh2V8 wire has been used on the rolls of roughing stands of mill 330. Inspection of rolls built up by using wire of steel 30KhGSA showed them to have a longer life than rolls of steel 55Kh. The extent of increased life was not definitely established,however, due to inadequate experience.

As stated by Comrade Smirnov, the Nizhne-Tagil metallurgical combine is employing welding build-up for rolls of the rail mill using 30KhGSA wire and is commencing to adopt build-up with powder wire of PP-3Kh2B8 quality. Wire of 30KhGSA steel has been used for restoring the dimensions of the passes of the rolls of blooming mill 1150 of stand 900 of the rail rolling mill.

Build-up by welding is also employed for redressing rolls to other sections (for example on old rolls for No. 55 joists the passes after building up were dressed for rails, rounds and squares).

Before building up, rolls of 50 and 60 KhN steel are heated to 300°C.

Comrade Shevchenko (Frunze metallurgical works) described how rolls of the roughing stands of mill 585 are built-up. The use of build-up by welding has resulted in a reduction in the number of stoppages of the mill for roll changing and an increase in its productivity. The increase in the life of the rolls and reduced wear of the passes in roughing stands has also had a favorable influence on the rolls of the finishing stand, which are now subject to less wear and ensure the required dimensions of the sections for a longer period, due to the more durable distribution of reduction in section among the passes of all the rolls.

The works has ceased to employ flame hardening of the surface of passes, as formerly used, since with the deposition of weld metal, the life of the rolls is 2-2.5 times that with hardened passes.

At the Lenin and Sinarsk works, the continuous tube-rolling mills have all been changed over to built-up rolls. The life of the rolls at the mill of the Lenin works, according to Comrade Vengerovsky, has been increased by 4.3 times for the most heavily loaded stand and by 9.6 times for the less heavily loaded stand. Before the application of build-up welding, the annual consumption of rolls was 380 rolls while during the period from 1953 to 1955, it was reduced to 10-11 rolls per year. Mill stoppages due to roll changing have been considerably reduced.

As stated by Comrade Brailovsky, at the Sinarsk tube works stoppages for roll changing have been reduced from 6 to 2.5%, and roll consumption has dropped considerably. Using build-up welding of 3Kh2V8 steel, it has been possible to roll tubes with the low wall thickness of 3.2 mm, resulting in an annual saving of 300,000 rubles on drawing. The total saving due to reduction in stoppages and in the consumption of rolls and fuel, etc. is 1,100,000 rubles per year (after deducting the cost of build-up welding).

At the Kuibyshev tube rolling works (information given by Comrade Borisenko), build-up by welding has been adopted for the rolls of a pilger mill on a special stand made by the E. O. Paton Institute of Electric Welding. The rolls are built up using PP-3Kh2V8 wire or wire of EI613 austenitic steel. It is not yet possible to say which of these steels is the better, but in 1956 the roll consumption was reduced by more than twice compared with 1955, while the life of the rolls after mounting has been increased 3-5 times.

Simultaneously with the introduction of build-up of rolls by welding, experiments have been made at some works on the application of build-up welding for repairing and increasing the service life of various parts of metallurgical equipment.

As stated by Comrade Leshchinsky, at the Magnitogorsk Metallurgical Combine, the blades of the blooming mill shears were first built up by welding. After welding the blades with PP-3Kh2V8 wire, their life was increased 2.5 times in comparison with the life of blades built up with Sormite alloy. Build-up welding was then adopted for the large and small bells of blast furnace charging apparatus. In the period 1955-1956, 10 large bells were built up, but it is not yet certain which is the best steel to use for this purpose, and to what extent the sort of steel affects the life of the bell. Many parts are built up by welding at the Combine – coke crusher rolls, rolls of rolling mill tables, brake blocks, etc.

The majority of speakers emphasized the inadequate supply of electrode wire, fluxes, transformers, and also the fact that up to the present, no decision has been made regarding the centralized manufacture of welding machines and equipment.

Conference recommended adoption by works of the following methods of build up by machine welding:

(1) For maximum increase in the wear resistance of steel rolls for plate mills, section rolling mills and tube mills, use build-up welding of steel type 3Kh2V8 with powder wire PP-3Kh2V8 or wire rod EI701 under flux AN-20 with preliminary heating of the rolls to 350-400°C.

(2) For increasing the wear resistance of rolls of pilger mills and roughing mills, use build-up welding with austenitic steel EI613 under flux AN-20, with preliminary heating of the rolls to 150-200°C;

(3) For restoring the dimensions of rolls, use build-up welding with wire 30KhGSA under flux AN-348A or AN-20 with preliminary heating to 200-250°C;

In addition, Conference made the following suggestions to works:

(a) For heating the rolls, use induction heating with current of industrial frequency;

(b) Produce by their own efforts very simple build-up welding machines, using old lathe beds for this purpose;

(c) For the build up of parts, use the following machines:

Diameter of part, mm	50-200	250-800	Above 800	Flat parts
Machine	A-409	A-384	A-513	A-384 and A-513.

Conference recommended that build-up by automatic welding should be adopted for the following steel parts: rolls of hot rolling mills, crane wheels, rolls of mill tables, blades for hot metal shears, centers of grab cranes, scraper blades, rolls of coke crushers, track rollers for excavators and tractors, slides of slag ladles, metal ladles and various trucks, protective lining plates of sinter plant, blast furnace and ore mining equipment.

Conference passed a resolution requesting the E. O. Paton Institute of Electric Welding to develop new types of electrode wire, a process for building up a layer of bronze on steel parts and apparatus for build-up

welding of rolls of different types by submerged arc welding and a new method for building up metal cutting blades by welding, to produce a better design of build-up welding machines, to produce and supply works with build-up apparatus for completing equipment.

Conference noted the positive experience of the "Azovstal" and "Dneprospetsstal" works in building up rolls under a ceramic flux and recommended that these works should continue the work and publish the results; conference also recommended that the Zhdanov Metallurgical Institute and the Kiev Polytechnic Institute should continue their investigations on build-up under ceramic fluxes with the object of obtaining maximum increase in the life of parts and in their economic effectiveness.

LETTER TO THE EDITOR

There has long been a requirement to revise the standards used for the grading of hot rolled products. Different systems of tolerances for round, square and flat sections complicate the work of rolling shops. When executing orders in accordance with GOST 2590-51, 2591-51 and 1133-48, the reserve of finishing stands is doubled and consequently so is roll changing. There is no agreement between the tolerances for the same size, so that mills which manufacture a wide variety of rolled products are obliged to carry a large number of measuring tools (gages, calipers).

The following table shows the comparative data of the sections with the different tolerances and the sizes of the gages (calipers) required for measuring these sections.

GOST	Section		Tolerances	Measuring gage
2590—51	Round	10	+0,4 —0,5	9,5—10—10,4
1133—48	Round	10	+0,5	10—10.5
103—51	Flat:			
	Width	10	+0.5 —1	9—10—10,5
	Thickness	10	+0.3 —0.5	9,5—10—10.3
4405	Flat:			
	Width	10	+0.5	10—10.5
	Thickness	10	+0.6	10—10.6
2590—51	Round	30	+0.5 —0.75	29.25—30—30.5
1133—48	Round	30	+0.9	30—30,9
103—51	Flat:			
	Width	30	+0.5 —1	29—30—30,5
	Thickness	30	+0.3 —1,2	28.8—30—30,3
4405	Thickness	30	+1.2	30—31,2
	Width	30	+1	30—31
	"	30	+0,8	30—30.8
	"	30	+0.6	30—30.6
	"	30	+0.5	30—30.5

Thus, for gaging 10 mm hot rolled product, 7 sizes of gage (calipers) are required, and for 30 mm products, 11 calipers are required.

At works with grades of rolled round sections 6-100 mm, hexagon, strips, squares and flats, the number of calipers goes into thousands, each of which costs from 50 to 90 rubles. It is essential that there should be an early decision to produce uniform dimensional tolerances, irrespective of the section of the rolled product.

It should be noted that basically hot rolled products are manufactured in accordance with GOST 2590-51, 2591-51 and 103-51. Practical experience at some rolling mills has shown that in the course of several years ball-bearing steel and high speed cutting steel have been supplied to customers, by agreement, with bilateral tolerances. For instance, the machine construction industry may require a certain rolled product. In developing the technology, the machine constructors must start from a single system of tolerances for rolled products, for which some extension of the grading of rolled products may be required.

The length of flats also should be unified in the limits of 3-6 meters, but for mechanized adjustments double the length may be allowed, i.e., 6-12 meters. This will make it possible to unify the weight of billets after blooming and roughing mills.

The standards for round bars, flat bars and other mass produced sections ought to be revised and unified, one set of tolerances being formulated for section and length. This would have a profound economic repercussion in the country.

E. P. Bazhina
Rolling Mill Engineer

[Comrade Bazhina's proposal for the unification of standards for similar products and for establishing single tolerances for cross section and length of rolled sections deserves attention. The Editor is asking the Committee for Standards and Measuring Instruments attached to the Council of Ministers of the U.S.S.R. to consider and lend support to this proposal.]

HARDWARE PRODUCTION

discussion

CONTINUOUS AUTOMATIC PRODUCTION LINES FOR WOOD-SCREW MANUFACTURE

S. A. Morozov

(Technical Department of the Principal Administration
of the Hardware Industry, Ministry of Ferrous Metallurgy, U.S.S.R.)

In the manufacture of wood screws by modern methods, the blank is headed on cold upsetting machines, using dies with special hard alloy facings. Simultaneously with the upsetting of the head, the shank is reduced for thread-rolling. In the technical process employed at some works (Moscow "Proletarsky Trud," Dnepropetrovsk "Krasny Profintern" and the Revdinsk hardware works), the screw blank is then pointed, the slot machined and the thread rolled.

These are the basic technical operations in the manufacture of screws with rolled threads.

At the Magnitogorsk hardware works, the screw blank is ground after heading, the thread is then rolled, the screw shank being pointed at the same time by means of special screw dies. In accordance with accepted technology, the equipment comprises: cold heading presses, pointing machines, automatic slotting and thread-rolling machines. At the Magnitogorsk works, automatic pointing machines are not included in this equipment, the operation of pointing the shank being combined with thread rolling.

What is it that induces hardware works to manufacture screws with rolled threads of the same dimensions by different technical methods? In the first place, pointing and slotting machines suffer from considerable constructional drawbacks. When using the automatic pointing machines type LT-1 and LT-3, it is impossible to ensure cutting of the screw blanks to equal length; consequently, in thread rolling, a large number of rejects and second quality screws are produced. To obviate this drawback, some works have endeavored to improve the concstruction of pointing machines, while others do not point the screw as a special operation, but combine it with thread rolling, using special dies. Such a decision, however, means a much more complex construction of the dies and their adjustment; furthermore, the quality of screws with thread rolled in compound dies is somewhat inferior. This gives reason to believe that the end of the blank should certainly be pointed before thread rolling. Since the existing automatic pointing machines type LT-1 and LT-3 are unable to guarantee constant length of the cut blanks, a new improved automatic pointing machine ought to be designed.

The special design office of the Ministry of Machine Tool Industry of the U.S.S.R. has produced an automatic pointing machine of new design, which operates on the milling principle. The machine is designed to point the ends of screw blanks with diameters from 1.5 to 4.0 mm, but according to reports from users at the "Proletarsky Trud" works, the construction of the machine is too complicated. At the present time, this works has under development a design for a machine which will combine both operations of pointing the end of the shank and cutting the slot in one machine.

Pointing is followed by cutting of the slot in the screw-head. At the "Proletarsky Trud," "Krasny Profintern" and Revdinsk hardare works, this operation is performed on automatic slotting machines type 7A590 and 7590C. These very complicated machines have a number of constructional drawbacks. The broaches of high speed steel R18 used for cutting the slots have a very short life and are also very expensive. This results in a pronounced drop in the economic efficiency of the machine and a high output of second quality products and much waste. During the machining of the slots, the broaches and cooled with spindle oil, which drops on

to the blank and is carried away with the latter. This loss of oil amounts to 9 kg per ton of screw-blanks slotted.

The only merit of automatic slotting machines, i.e., their high theoretical capacity (up to 320 screws per minute), cannot be utilized at present. Actually, as shown by a working trial at the Magnitogorsk hardware works, to reduce waste and the amount of second quality screws, the equipment must be arranged in a continuous, automatically operating line. With the equipment arranged in this way, the productivity of all the machines ought to be approximately the same.

The average productivity of the cold-heading and thread-rolling machines is 95-115 screws per minute. If, therefore, automatic slotting machines are included in the line, they will be utilized only to one-third of their capacity. The equipment cannot be arranged in line so that one automatic machine receives the blanks from 2 or 3 cold headers and then transfers them to 2 or 3 thread-rolling machines. This would result in mixing the screw blanks from different cold headers, which is inadmissible, since mixing appears to be one of the principal causes for the high proportion of second quality and rejected screws when rolling the thread.

I. D. Kabanov, G. Ya. Vyacheslavov and N. Ya. Volnikov, rationalizers at the Magnitogorsk hardware works, have proposed the use of suitably modified automatic slotting machines type LT-3. As screw-slotting tool, these authors propose to use segment type broaches. The manufacture of such broaches is rather more complicated than that of ordinary flat broaches and their life is shorter, due to the higher specific load per tooth and the impossibility of re-grinding. Furthermore, the construction of the slotting machine being imperfect, its adaptation for slot cutting can be justified only as a temporary measure. At the Gorki works "Krasnaya Etna," slots in the heads of wood screws, metal screws and bolts of diameter 3-8 mm are cut on slot milling machines manufactured by foreign firms ("Kaiser," "Manville," "Waterbury") with a capacity of 20 to 120 per minute. The machines are simple in construction and reliable in operation, so that one workman can easily attend to 7 or 8 machines. The quality of slotting on these machines is high. The tools employed are made of plain carbon tool steel and are much cheaper than broaches.

At the Third European Machine Tool Exhibition in Brussels, 1953, slotting machines made by the firms of Bofors (Sweden), E. V. Männ Gilchenbach (Westphalia) and the machine tool works of Peltzer and Ehlers (Krefeld) were exhibited. On these machines, the slots were cut by means of band saws instead of the previously used milling cutters. This improvement increases the capacity of the machines and reduces production costs.

At the present time, the "Proletarsky Trud" works has under project a combined automatic machine for pointing screw blanks and cutting the slots. In this machine, it is proposed to use slot milling cutters. In our view, from the point of view of screw manufacture, it would be better to design automatic machines to carry out each operation separately. This would mean that their construction could be simpler, which would considerably facilitate operation and servicing.

EXPERIENCE OF INNOVATORS

WORKING METHODS OF FLAME CUTTER OPERATORS E. F. ABROSIMOV AND D. P. SEMIKHATOV

V. A. Galkov

(Head of Research Laboratory for Organization of Production and Labor)

V. L. Sitnikov

(Leader of Rolling Mill Group of the Laboratory "Krasny Oktyabr" Works)

Torch scarfing of steel slabs and blooms is the most productive and cheapest method of preparing them for rolling. This method of scarfing has been in use at our works since 1948, and at the present time has completely displaced hammer scarfing in the blooming mill shop.

The torch operators produce their maximum output on medium grade slabs. In the first six months of 1956, the output per shift per torch was 63 tons. Better results have been obtained by E. F. Abrosimov and D. P. Semikhatov. In a shift, they scarf up to 72-75 tons of slabs, i.e., 15 to 20% more than the other operators.

The most effective method of scarfing slabs is the "fir tree" or "herringbone" cut. With such a method of cutting, the depth and width of the cut can be controlled to a considerable degree, the torch has considerable stability and does not stick in the metal. Comrade Semikhatov is very skilled in this method. According to the depth of the flaw, he increases or diminishes the frequency of oscillation of the torch (maximum frequency 3 per second). The deeper the flaw, the higher is the frequency of oscillation of the torch. In isolated cases, when scarfing fine shallow cracks and scabs, Semikhatov reduces the frequency of oscillation of the torch to 1-1.5 per second, simultaneously increasing the width of cut. A 190 mm face is scarfed in 1 or 2 passes of the torch and a 220 mm face in 2 or 3 passes. The cut produced by Comrade Semikhatov is even in depth and width.

The "herringbone" cut is also widely used by other operators and in particular by Comrade Abrosimov. With him, however, the oscillation frequency of the torch, upon which depends clean scarfing and stability of cut, does not exceed 1.5 or 2 per second.

The method of torch scarfing using the "groove" cut was the principal method employed when torch scarfing was first adopted, but now it is used only for scarfing shallow cracks and other insignificant flaws.

The rate of cut depends primarily upon the angle of inclination of the torch head to the scarfed surface, the depth of cut and the amount of oxygen supplied through the nozzle to the flame.

When making the "herringbone" cut, E. F. Abrosimov and D. P. Semikhatov use a mean working angle of cut of 25-30°, the maximum being 45-50°. The deeper the flaw, the steeper is the setting of the torch head.

These two operators use different rates of cutting and scarfed widths. Thus, Semikhatov, for the overall scarfing of faces, uses a cutting speed of 5.7 meters/min (with variations in the limits of 9.3 to 3.4 meters/min). Semikhatov completes the overall scarfing of a 190 mm wide face primarily in 3 or 4 passes of the torch. This operation takes 3 minutes.

Comrade Abrosimov cuts at a mean speed of 3.5 meters/min (from 4.7 to 2.2 meters/min). He completes the overall scarfing of a 190 mm face in 5 or 6 passes, taking 4 minutes to do the face.

Comrade Semikhatov's high cutting speed is due to the fact that his valve on the cutting oxygen tube is full

open, thus supplying the maximum amount of oxygen to the flame. As a rule, Comrade Abrosimov does not open the valve fully, thereby restricting the flame. In this case the heat rays do not affect the operator so much, the working conditions are easier and he utilizes the working time more fully.

In overall scarfing, Comrade Abrosimov uses a turn-round cutting method. Passing the torch from right to left along the slab on approaching the other end, he reduces the speed of the torch somewhat and turns it through 95-105°, without stopping the feed of cutting oxygen. The stream of oxygen is turned round on the metal from left to right and the advance of the torch continues without interruption. The result is less time wasted on idle passes and relighting. Overall scarfing of a 190 mm face takes altogether 2 min 30 sec, instead of 4 min when cutting without turn-round. The torch output in a full hour is increased by 60%.

Different defects and flaws in the steel are removed differently. Fissures of a depth of from 5 to 15 mm and deep, long cracks are removed mainly in three passes, the first pass being made along the flaw to the full depth of its position. It should be remembered that if in the focus of the flame through the slag a white thread is still to be seen, the flaw has not been completely removed and the depth of cut must be increased. Comrades Abrosimov and Semikhatov always ensure that the crack is at the focus of the cutter flame. This minimizes loss of material.

When the flaw has been removed, a scarfing cut is made on both sides of the channel. The channel width exceeds the depth by not less than ten times.

In removing scabs and fine cracks, which are not very deep but cover the entire face, the width of cutting is increased, the oscillations of the torch being diminished. In this case, Comrade Abrosimov sometimes scarfs a face in one pass.

In removing continuous deep firecracks and fissures, Comrade Semikhatov sets the slab on edge. By this means, the slag is blown away better with the cutting oxygen valve full open and sufficient depth of scarfing is obtained.

Torch scarfing is operated by a team consisting of the torch operator and his assistant. Usually, the team works on 2 or 3 parallel stands. The duties of the assistant comprise marking the flaws, removing scale from the slabs and manipulating the latter. The ability of the assistant to determine the boundaries of flaws helps to increase the output of the team.

Torch operators D. P. Semikhatov and E. F. Abrosimov, by their high quality scarfing work, ensure almost complete removal of flaws. Consequently, cases of rescarfing of slabs after inspection are comparatively rare. Thus, in the case of Comrade Semikhatov, rescarfing of steel after inspection occupies 5% of his working time or 24 minutes per shift, while in the case of Comrade Abrosimov, it is 15.6% or 75 minutes per shift.

Comrade Semikhatov loses 7% of his working time or 34 minutes per shift while waiting for the examination of the metal by the inspector, while Comrade Abrosimov loses 11% or 53 minutes per shift.

In Comrade Abrosimov's team, the various scarfing operations are carried out simultaneously. While working at the first stand, Comrade Abrosimov follows the operation of manipulating and marking out the slabs on the second stand. If scarfing on the first stand is more laborious, Abrosimov first scarfs the less difficult metal on the second stand, thus ensuring a "working front" for his assistant.

In this way, the cutting torch operator wastes less time in waiting for cleaning, manipulating and marking out. In the case of Comrade Abrosimov, stoppages due to this cause amount to 9% or 43 minutes per shift, while in the case of Comrade Semikhatov, the figure is 18% or 95 minutes per shift, i.e., twice as long.

E. F. Abrosimov's assistant, Comrade Mityaev, himself does the marking out and manipulation of the slabs, thus ensuring work in good time for the torch operator. In the course of a shift, Comrade Abrosimov's is engaged on direct cutting for 66% of his working time, or 5 hours, 15 minutes, while Comrade Semikhatov is engaged 56% of the time or 4 hours 30 minutes.

Thus, the principal superiority of Comrade Semikhatov's work is the high cutting speed, while with Comrade Abrosimov the working time is evenly occupied during the entire shift.

The labor productivity for scarfing would be still higher if the assistants themselves learned to use the torch. Thus, at the Kuznetsk Metallurgical Combine, the output of teams where the assistants are able to use the torch is higher by 10 to 15%.

In particular, the working experience of assistant Comrade Ivanov (team of Comrade Novikov) deserves to be more widespread. During the absence of the torch operator, Ivanov himself carries out the operation of scarfing.

The more extensive adoption of the working methods of Comrades Abrosimov and Semikhatov will considerably increase the labor productivity of scarfing torch operators and improve the supply of slabs and blooms to the rolling mills.

NEW BOOKS

FERROUS METALLURGY IN CAPITALIST COUNTRIES

PART II. PREPARATION OF ORES FOR SMELTING AND BLAST FURNACE PRODUCTION

(Moscow, Metallurgy Press, 1957, 494 pp.)

The book gives an account of the contemporary position of blast furnace production in the U.S.A., Great Britain, France, Western Germany and other capitalist countries.

In the first section, Cand. Tech. Sciences V. S. Abramov discusses the preparation of ores for smelting at the works of these countries. Ore bedding is described in detail, much space is allocated to iron ore sintering and nodulizing and pelletizing of finely ground concentrates. In the "Summary" of this section, a brief account is given of information concerning the construction of machines used for preparing ore for smelting and the technology of this preparation. Appendices give the characteristics of sintering plants in operation in the U.S.A. and Great Britain.

In the large section "Blast furnace production," in addition to general data on the number and size of blast furnaces in capitalist countries, information is given concerning the construction of these furnaces, their auxiliary equipment, smelting technology and furnace repair. In this section, the reader will also find information regarding innovations in blast furnace smelting technology, use of oxygen enriched blast, high-pressure operation, oxygen blowing of iron in the hearth, desulfurizing and desiliconizing the iron outside the furnace, etc.

Part of the section is specially devoted to iron smelting in low shaft furnaces. A detailed analysis is made of furnace operation in Western Germany, Switzerland, Belgium, U.S.A. and other countries.

A special part deals with electric blast furnace production. The technology of iron smelting in arc and resistance furnaces is discussed in detail. Electric blast furnaces and ordinary furnaces are compared and an extensive review is given of electric blast furnace production.

Each part of the section "Blast furnace production" is provided with a summary and references to the literature.

The book will undoubtedly excite the interest of readers — engineers, technicians and highly qualified workmen engaged on blast furnace production and sintering.

INSPECTOR OF DEPARTMENT OF ROLLING MILL TECHNICAL CONTROL

V. V. Trofimov

(Moscow, Metallurgy Press, 1956, 163 pp.)

The first three chapters of this book deal with the fundamental knowledge of mathematics, physics, chemistry and metallography which an inspector of Department of Technical Control of a rolling mill shop ought to possess. Here the reader is acquainted with the methods of the chemical analysis of steel and the instruments used for measuring the dimensions of rolled sections.

The fourth chapter describes the methods used for the mechanical testing of metals for hardness and impact strength, and the technical specimens for bending, upsetting and other tests.

The fifth chapter, "Fundamentals of rolling technology" is devoted to rolling mill heating furnaces and the heating of metal before rolling, classification of mills, the actual rolling process, designing roll passes. Information is provided on the technological scheme of rolling and its accuracy.

In the sixth chapter, the author describes the defects of rolled articles, and in the seventh, the finishing and inspection of the final products.

The eighth chapter provides information regarding State Standards and the technical conditions governing rolled steel. Information is also provided with regard to branding the metal.

The ninth, tenth and eleventh chapters briefly outline the organization of technical inspection in rolling mill shops, the cost of production and the industrial safety regulations which an inspector ought to observe.

The book is intended as an aid in the instruction in matters of production and technology for workers who have not been through a course of instruction in the middle school, and also as a text book for industrial training.

DISCUSSION

ORGANIZATION OF THE REPAIR SERVICE IN METALLURGICAL WORKS

REPLY TO THE ARTICLE BY V. F. IVANOV (Metallurgist, 1957, N. 5)

A. I. Gurvits

(Structural Engineer of the Department of the Chief Engineer of the
Ministry of Ferrous Metallurgy, U.S.S.R.)

At the present time, the advantages of a centralized system for the repair of equipment over a decentralized system are obvious to any workshop engineer. The problem of the rational form of the organization of a repair service, however, has not yet been solved. V. F. Ivanov's article, therefore, is of interest, although one cannot agree with all his statements.

Comrade Ivanov proposes three forms for the organization of a repair service:

1. Group workshops, of the Magnitogorsk Metallurgical Combine type.

2. A single repair erecting shop with specialized sections, after the example of the "Azovstal" works.

3. A single repair machine shop, producing spares for repairs and carrying out all the repair work in the principal departments of the works.

The first form is recommended for a small circle of very large metallurgical works, comprising a large number of principal plants and possessing a large stock of machine tools, which may be transferred to the group workshops without disadvantage to the principal machine shop.

The author recommends the second form for metallurgical works possessing many plants and the third for works having a small number of not very large plants.

We shall try to analyze these recommendations.

It is known that according to all the criteria of repair service – frequency and duration of stoppages for repairs, labor productivity and cost of repairs – the best results are obtained by the Magnitogorsk and Kuznetsk Combines. At the same time, the repair service is organized differently at each of these combines.

At the Magnitogorsk Combine, the group system is represented in the most regular form. The group workshops, i.e., rolling mill, open-hearth, coke-ovens and mining shops, make some of the parts required for the repair of equipment, and carry out repair work in their principal plants in strict accordance with the approved diagrams showing the planned preventive repairs. At the Kuznetsk Combine, however, there are no group workshops, the repair work in the principal plants is carried out by crews of repair workers, forming part of a shop, which is called the "repair machine" shop to distinguish it from the two machine shops which make all the necessary spare parts for repair.

In addition, at the Kuznetsk Metallurgical Combine, repair work is also carried out by workers on production at the main plants who possess a second trade, i.e., equipment repair fitters.

Despite this difference, the two forms of organization of repair service, judging by the results obtained with them, are perfectly satisfactory, and yet for large works covering several plants with similar products, preference should always be given to the group system.

What is the single repair-erecting shop, existing at the "Azovstal" works and recommended by Comrade Ivanov, and how does this form of organization of a repair service differ from those described above?

This single "repair-erecting shop" differs from the Kuznetsk "repair-machine shop" by having two separate specialized sections, carrying out repairs on rolling mill, blast furnace and steel melting equipment, and a third section, a "boiler-erecting" section. Thus, at the "Azovstal" works, there is no territorially single shop.

In contrast to the group system employed at the Magnitogorsk Metallurgical Combine, the above-mentioned sections do not comprise machine shops with a stock of machine tools.

At the "Azovstal" works, however, in the rolling mill plant, there is a machine shop, which may well be the envy of the "rolling mill" repair group of any metallurgical works. It is true that here it is called No. 2 machine shop, but this does not alter the fact that the "rolling mill group" has been intentionally divided into two sections, one of which is subordinate to the chief engineer, and the other to the head of the "single repair-erecting shop."

The boiler-erecting section forms part of the "single repair-erecting shop." Does not this explain the fact that until recently at the "Azovstal" works there has been a steel construction shop and its functions have been carried out and are still carried out by a small shop situated in front of the principal machine shop. What will be left of this boiler-erecting section when the restored steel construction shop, handed over to the works of the Ministry of Metallurgical and Chemical Constructions, starts up again and when the machine shop demands the return of its floor space?

It is pertinent to point out that at the Magnitogorsk Metallurgical Combine, the repair-erecting section carrying out repairs of steel constructions in the principal plants is part of the large repair-boiler shop (steel construction shop) of the Combine.

As will be seen, the organizational form of the repair service at the "Azovstal" works is a "poor edition" of the experience at the Magnitogorsk and Kuznetsk Metallurgical Combine, is not worth considering as a special form and can hardly serve as pattern for other works.

At the same time, one cannot deny the expediency and in isolated cases the necessity of the organization at large metallurgical works of genuine repair-erecting shops which would really fit the name.

Such a shop may have the following sections:

(a) Section for the repair of movable equipment: iron ladles, slag ladles, trucks for charging boxes and ingot moulds.

(b) Fitting and assembling section for cleaning, inspection and sorting of units of equipment dismantled during repairs and reassembling these units and machinery after receiving them from the machine shop or from the store of new or repaired parts, in place of worn parts.

(c) Section for the preservation and repair of erecting machinery, fixtures and tools.

The repair-erecting shop may also include small machine shops, forging and welding shops and hardware shops for producing small parts required for the assembly of repaired units and machinery.

The workers in the repair-erecting shop should consist of composite crews, specialized in the repair of certain articles of equipment.

NEW DEVELOPMENTS IN SCIENCE AND TECHNOLOGY

CYBERNETICS AND METALLURGY

Cand. Phys. Math. Sciences Yu. A. Shreider

Automation and mechanization are not infrequently confused. They are quite different things, although in a number of cases, automation is possible only if the fundamental processes are mechanized. For example, if an ingot is conveyed to the rolls by means of a roller table and not by hand by the mill operator, this is mechanization. Here, the machine has replaced the hands of the man. There is still, however, an operator at the control desk, watching the ingot and regulating by means of the controller the speed and direction of rotation of the rolls. At speeds of the rolled piece of several tens of meters per second, the operator is unable to follow all the details of the process to ensure adequately correct dimensions of the final product. In this case, automation is already necessary. The automatic machine should replace the operator and, reacting to the change in dimensions of the treated metal, should alter the speed of rotation of the rolls so that variations in thickness of the rolled material will be minimal.

In such a case, it is already possible to use a cybernetic machine which can perform separate functions of the human brain, just as some machines perform the functions of human hands. The creation of such machines, regulating different parameters and the technological process as a whole has become possible through the development of computing techniques.

There are two fundamental types of electronic machines – continuous machines and digital machines. The continuous machines (analogue machines) as a rule solve systems of differential equations describing a certain process. Digital computers solve numerical problems in which numbers are represented by digits. The various arithmetical operations on the numbers are performed by means of electronic circuits. Modern computers perform tens of thousands of additions, multiplications or divisions per second.

A typical computer (Fig. 1) comprises an arithmetical unit AU, where the operations on the figures are performed; an operative store ST, where the intermediate results are stored; external units EU by means of which the original data are fed into the machine and the results are read out; and a magnetic tape store MTS, which serves for lengthy storage of large numbers of auxiliary data. Digital computers perform not only arithmetical operations but also logical operations: the selection of one variant or another of the solution according to certain criteria worked out by the machine, comparison of the results of the solution of a problem with the data received from the controlled object, etc.

The controlling systems employed are specialized computers, the general arrangement of which is shown in Fig. 2. The measuring device M picks up data relative to the entry of the controlled article A. These data are processed by the computing unit CU, which computes the best working conditions for the article, taking into accout the varying working conditions on entry. Data as to what actually occurs at the exit of the article can be resupplied by means of the measuring device M_1 to the computing unit CU, thereby correcting the work of the latter. At the same time, the computer by remembering the results obtained in the store, can select the best method of control not only according to the results obtained at the given moment, but according to the results of the treatment of the article after the lapse of a certain period of time. The computer thus compensates the harmful disturbances acting at the entry of the controlled article and accumulates experience, permitting selection of the best working conditions for the article.

The specialized computers used in control systems are distinguished by their relative simplicity and cheapness from the universal computers employed for theoretical investigations.

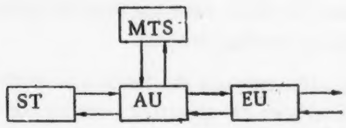


Fig. 1. Diagram of digital computer.

The application of an automatic control device, which is at the same time a computer, to a strip rolling mill permitted the tolerances to be reduced by six times. The measured thickness of the strip entering the first stand is fed to the computer unit CU (Fig. 3), which evaluates the correction to be made in the operation of the motor of the third stand.

The computer unit is a continuous machine adapted to solve a system of differential equations, describing the rolling process and the behavior of the electric drive. The working conditions of the motor are varied with a delay so that, at the moment when the portion of strip measured at the entry will be gripped by the rolls of the second stand, the speed of rotation of the rolls of the third stand will be such that the tension produced between the third and second stands will compensate for the measured unequal thickness of the strip.

There are different degrees of automation depending upon the complexity of the problems to be solved by the machine, the number of factors to be taken into account and the diversity of the possible situations for which the system of automatic control has to find a solution. In this sense, machine controlling a rolling mill on the principle described above is relatively simple, since the situations occurring at entry differ only in the thickness of the entering strip. A higher level of automation would be required if it were necessary to take into account the influence of varying temperature and elastic properties of the rolled metal.

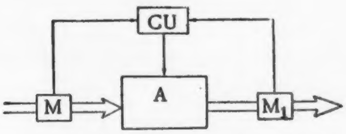


Fig. 2. Diagram showing control of a process by means of a cybernetic machine.

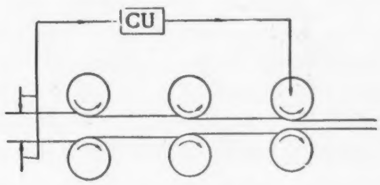


Fig. 3. Diagram showing method of controlling strip thickness during rolling by means of a cybernetic machine.

For hot rolling mills, compensation for varying thickness may be brought about by automatic control of the screwdown gear.

The introduction of automation must have some influence on the constructional features of rolling mills; it will be necessary to be able to vary quickly the speed of the rolls or the position of the screwdown gear, which requires an increase in motor power. On the other hand, it is possible to accept some easing of the requirements regarding roll rigidity, due to the possibility of compensating any deflections.

A cybernetic machine should not only facilitate human control of production, but help us in understanding a complicated process and accepting the correct solution. Such equipment will enable the production process to be improved without modification in the essential equipment. Computers can carry out a statistical analysis of the characteristics of a technical process. When rolling sections, it is possible by determining the mean values and scatter of the dimensions of the rolled products, according to a few first reduction specimens, to compute the optimum values of reduction on different stands and introduce at once the appropriate corrections into the working conditions of a rolling mill. By accumulating and analyzing working experience, it is possible to select the best conditions for the treatment of a given ingot according to the results of the previous treatments of similar ingots in different conditions.

Interesting problems arise in the automation of a process when we do not possess complete information as to its course. Blast furnace production is such a process. The complete mathematical description of the blast furnace process is unknown, and it is hardly likely that it can be realized. The attempt made by Professor

V. A. Sorokin to ascertain at any given instant the productivity of a blast furnace and the relative coke consumption as a function of the quantity of blast and the degree of development of direct and indirect reduction does not appear to be a complete solution of the control problem, since the proposed equation does not reflect such an important characteristic as the regularity or smoothness of operation of the furnace. Professor Karadeev's computing machine set up at the "Azovstal" works for solving Professor Sorokin's equation does therefore not enable us to solve the problem of the optimum conduct of the blast furnace smelting process.

This problem could only be solved by a machine which, to commence with, operates the furnace according to a set program, remembering and analyzing the deviations of the furnace from the specified working conditions and modifying the program as a final result. Measured parameters (characteristic of the burden, top gases, etc.) are used for making a selection of the best working conditions of the furnace. The operation of every blast furnace differs in its individual peculiarities, and therefore the furnace characteristics become more precise in the working process. The generalized data on the furnace working may be stored on a magnetic tape. Data of this sort may possibly be selected combinations of those external factors which affect most strongly the conduct of the furnace (type of raw material, humidity of blast, etc.). The current parameters of the process may be compared with those previously recorded and a mode of conduct of the furnace may be selected in accordance with experience already accumulated. Such an accumulation of experience is particularly important in machines controlling a larger technical complex, such as a plant or an entire works.

Attempts to consider an entire concern as a system which can be automatically controlled have been published in the foreign literature. The existing theory of "linear programming" provides a method of selecting to some extent the best method of controlling a concern according to its economic criteria.

In selecting the optimum production conditions it is obviously expedient to combine the solution of economic and technical problems. The computing machine, on the basis of order forms, would be able to select the best method of organizing production and issue tasks to the plants for execution by day or by shift by taking into consideration any departures of the following criteria from those as planned: arrival of raw materials, the progress of execution of the plan by individual plants and units, availability of transport, unoccupied storage space, etc. The application of such current planning by means of a machine could lower expenditure in readjusting mills and altering the working conditions of the furnaces, reduce the consumption of steel by utilizing for other orders rolled material outside the tolerances, etc.

OUTSTANDING METALLURGISTS

ACADEMICIAN N. P. CHIZHEVSKY

Professor, Doctor of Technical Sciences D. V. Nagorsky

Nikolai Prokopyevich Chizhevsky was born in Kazan on April 12th (March 31st) 1873.

On leaving the Eletsk high school in autumn 1895, N. P. Chizhevsky entered the St. Petersburg University in the natural science section of the physicomathematical faculty. He was attracted, however, not only by natural sciences but also by art, and he thus became a student of both the university and the Academy of Arts at the same time.

After three years of study, he was faced with the problem as to which path he should take – should he become a chemist or an artist. At this time, at the university he had entered the special organic chemistry laboratory of Prof. A. E. Favorsky, and at the Academy of Arts he had entered the special workshops. It was impossible to combine both these, as this would have demanded excessive strain.

N. P. Chizhevsky chose science.

The middle of the nineties was a remarkable period: a young social trend – Marxism – had come into being.

The Petersburg students used to attend meetings of the Free Economic Society, where Marxists made speeches and Plekhanov's books were read, as well as the hectographed book by Lenin: Who the "People's Friends" are, and How They Fight Against the Social-Democrats. In student circles, impassioned arguments arose between the Populists and Marxists. N. P. Chizhevsky joined the Marxists.

In 1899, a wave of student revolutionary actions ran throughout all the higher educational establishments. At the St. Petersburg university, there were a number of student gatherings; many students were excluded from the university without the right of entering other higher educational establishments and were banned from St. Petersburg. N. P. Chizhevsky was among them. Before these events occurred, Chizhevsky had completed the university course; he had only to pass the state examination and receive his diploma, but he was prevented from doing this by his exclusion from the university and banishment.

In autumn 1899, the excluded students decided to complete their education abroad, and Chizhevsky went, too. He chose the small Austrian university town of Leoben in the Styrian Alps. The Leoben Academy was very favorably situated among the concerns of the ironfounding industry, which were visited weekly by students in their final course. In the vicinity of Leoben, there was an inexhaustible deposit of iron spar, which had been worked from Roman times, and there was a small works consisting of refinery hearths and an old blast furnace; in addition, near Leoben was the Donavitz works, a large one for that period, with large blast furnaces, a large open hearth plant and the most powerful blooming mill in Europe.

The Russian students who studied with such enthusiasm were called "aspirants" by the Germans. Chizhevsky, who was one of them and had received a solid scientific background at the university, decided to complete the entire course of Academy in two years, and during these two years he studied diligently, mainly subjects dealing with ferrous metallurgy. At that time, the professor of ferrous metallurgy at the Leoben Academy was Ehrenbert, who had a good knowledge of metallurgical production. During the final course, he personally conducted visits to works in the neighborhood.

The Academy course was completed by an extensive tour of the metallurgical regions of Austria, in which at that time there were about 40 large works. The tour was made under the leadership of the professor and was called the "works tour." Much of what had been studied theoretically could be seen in practice, and it was possible to discuss matters in person with leading engineers.

N. P. Chizhevsky successfully passed the state examinations, receiving the diploma with distinction. He had a wide general scientific background with a wide knowledge of the field of metallurgy. The parts of the examiner and the student were often exchanged: on occasion, the students reply became a lecture to which all present listened with interest.

By chance, the famous Russian professor metallurgist V. P. Izhevsky was present at the examination. Chizhevsky's replies made such a profound impression on him that he thereupon offered Chizhevsky the post of assistant in the metallurgical faculty created in the reestablished Kiev Polytechnic Institute.

In this institute, Chizhevsky carried all the responsibility for the organization of the laboratories and the theoretical studies of the metallurgical students.

In addition to this, Chizhevsky commenced to carry out scientific research work, chiefly on metallography. During the vacations, he visited the southern works and extended his knowledge of blast furnace and open hearth furnace operation. In Kiev, too, was laid the foundation of his great investigation of the iron-nitrogen and iron-boron systems, which subsequently served as subject for his thesis. In addition, he produced several important translations (including Ledebur's handbook on the analysis of iron, to which Chizhevsky made a number of contributions).

In order to obtain a Russian diploma, N. P. Chizhevsky, while continuing to work in the faculty, enrolled as a student of the institute. Having received the diploma of engineer-metallurgist, he went abroad to the Aachen Polytechnic Institute, which had a well-equipped metallographical laboratory. It was there that Chizhevsky amplified his data on the investigation of the iron-nitrogen system. His thesis on this subject was presented at the Kiev Polytechnic Institute in 1913.

In the same year, Chizhevsky was invited to teach metallurgy at the Tomsk Technological Institute, where after presenting this thesis, he was appointed principal of the metallurgical faculty.

At the Tomsk Institute, Chizhevsky continued the scientific research work he had commenced in Kiev. At first, his attention was drawn to purely metallurgical subjects – metallography, and the investigation of the iron-nitrogen, iron-boron and iron-carbon systems. But during his stay in Tomsk, life faced him with a personal problem, out of which grew an entire complex of problems. Their solution formed the basis of the whole of his subsequent scientific work.

Deposits of coal had been discovered in the province of Tomsk. Without making the necessary investigations, the owners decided to build coke ovens for supplying coke to a small blast furnace plant. The ovens were built, plenty of rubbish was produced, but no coke. The owners applied to the Tomsk Institute for advice and N. P. Chizhevsky dealt with the problem.

After carrying out some fairly simple investigations, Chizhevsky discovered that the coals used for coking were non-caking or practically non-caking. It was possible to remedy the situation by ramming the charge before coking and rationally selecting the various coals, blending the better caking coals with the non-caking varieties, etc. After making a number of preparatory laboratory experiments, Chizhevsky continued to work on the spot at the Anzhero-Sudzhensky mines, where ovens which had not been used for several years were repaired and the carpenters made several boxes in the form of coke oven chambers. Different sorts of finely ground coal in different porportions were rammed in these boxes and the boxes were placed in the heated coke-oven chambers, resulting in the production of coke, the quality of which depended upon the mixtures employed and the nature of the ramming. It was thus possible to produce metallurgical coke which satisfied all requirements.

For N. P. Chizhevsky, the experiments at the Anzhero-Sudzhensky mines were the starting point in the solution of a large national problem: if in this case, simple technical devices had logically resulted in the possibility of producing good coke, then applied on a large scale to the south of Russia this would help to avoid an enormous calamity, viz. the imminent coke shortage in a large area supplying the country with steel.

In 1923, N. P. Chizhevsky became professor of the Moscow Mining Academy, and a little latter, of the Steel Institute, an offshoot of the Academy. In 1939, he was selected Member of the Academy of Sciences of U. S. S. R.

Chizhevsky's term of duty at the Mining Academy and the Steel Institute was most fruitful. The more important work he performed during these years includes the investigation of the iron-boron system, the part played by gases in steel, nitriding of steel, vacuum melting, the direct reduction of iron, high-temperature resistant and other high quality steels, and the direct application of peat in blast furnace smelting, using ordinary and oxygen-enriched blast. As previously, however, N. P. Chizhevsky's main attention was directed to extending the raw material basis of coke-oven practice.

The work in this field followed three main directions: ramming badly caking coals before coking, blending and ramming the coal charge and the production of ferro-coke and its smelting in the blast furnace.

N. P. Chizhevsky has been able to show that by blending and ramming, it is possible to introduce up to 35-40% of brown coal into the coal charge and produce good metallurgical coke.

Chizhevsky took part in the operation of blast furnaces directly on peat without previously coking it. Unfortunately, these production trials, although they gave interesting results, were never completed.

An important link in the chain of work on the extension of the raw material basis of coke-oven practice has been Chizhevsky's work on ferro-coke.

Ferro-coke is produced from a coke-oven charge, in which a considerable quantity of fine ore or blast furnace dust has been added to the crushed coal. Work on the problem of producing ferro-coke was first done by the engineer Auerbach at the same time as the prominent Russian engineer-blast-furnace specialists A. A. Svitsin; the results of their investigations were published in the "Gorny Zhurnal" in 1905.

Experiments on blending fine ore with the coal charge were also carried out abroad. Not very much ore was added to the mixture, however, and being an addition which made the mixture lean, it did not help in increasing the strength of the coke.

N. P. Chizhevsky, working on the problem of increasing the raw material basis of the coke industry, renewed the work on ferro-coke. He increased the iron content in the resulting ferro-coke to 30-40% and transferred the experiments to industrial conditions. With large additions of ore, the iron reduced at the coke oven temperature was welded into a continuous network, a sponge, which assisted in forming larger pieces of coke and in increasing their strength. When dropped from a considerable height, the pieces were not shattered (unlike ordinary coke) and the noise of impact was dull, as when a viscous substance was dropped. The low friability of ferro-coke gave promise of the formation of only a small amount of breeze which would assist the smoother operation of the blast furnace.

With considerable difficiulty, N. P. Chizhevsky obtained permission to burn 200 tons of ferro-coke and carry out experiments on a small blast furnace at the Frunze works. The use of ferro-coke in the burden considerably increased the productivity of the furnace: the blowing equipment was inadequate and the furnace was therefore operating all the time with the shaft incompletely filled.

Despite these results, the State Institute for the Planning of Industrial By-Product Coke Establishments adopted a negative attitude to the work on the use of ferro-coke and further experiments on its use in the blast furnace were stopped. In the meantime, a large number of articles have recently appeared in the foreign literature, devoted to ferro-coke and making little reference to Russian work. In the U.S.A. in 1955-1956, the largest concerns manufactured many tens of thousands of tons of ferro-coke and are carrying out experimental smelting operations in blast furnaces. Tens of thousands of tons of ferro-coke have been burnt in Europe, principally in western Germany. The question of ferro-coke is being discussed in various scientific-technical societies, where it is considered that the use of ferro-coke promises considerable practical advantages.

N. P. Chizhevsky died on April 22, 1952, at the age of 79. His work in the field of extending the raw

material basis of the coke-oven industry (production of ferro-coke) has not yet become as widely known here in Russia as it ought to be. At the present time, our metallurgists are carrying out an extensive investigation on the production and utilization of ferro-coke.

FROM THE HISTORY OF TECHNOLOGY

FROM THE PAST OF THE URAL METALLURGICAL INDUSTRY

The Kamenny Poyas, the mountain range of the Urals, conceals enormous riches, including the ores of practically every metal, gems, asbestos (amianthus) and coal. Timber occupies a considerable area of the Urals; the rivers supply cheap water power. All this had been known from time immemorial, but due to the small population of this part of the country, the natural riches of the Urals remained unexploited.

It is true that the Urals had small mines and works used by the local inhabitants for winning copper ore and smelting the copper. These "wonder mines" remained until the 18th century and showed later prospectors the places where copper ore was to be found.

With the growth and development of Russian sovereignty, enterprising merchants and industrialists penetrated more and more towards the east. They knew of the wealth of the Urals, but the lack of labor prevented them from working the ore and building works. Even the rich merchants, the Stroganovs, who at the end of the 16th century received from the Tsar Ivan the Terrible license to work the Ural ores and produce metal did not exploit these privileges. They commenced the gradual colonization of the Urals.

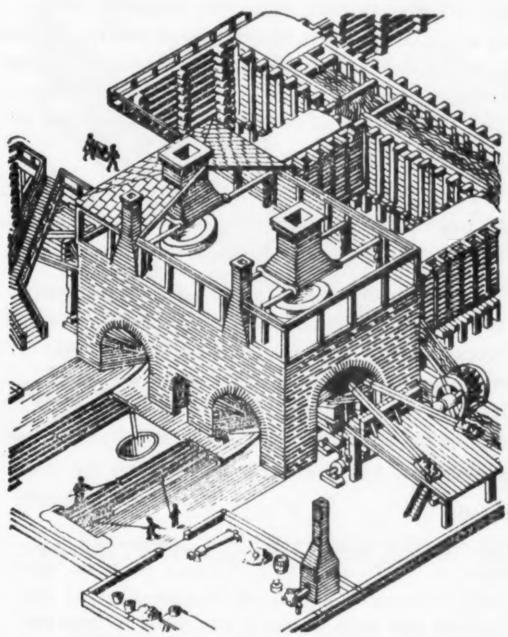


Fig. 1. Blast furnaces at an old Ural works.

In 1628, the Tobolsk voivode Korsakov received a declaration from a native of the Urals concerning an iron-ore deposit near the river Nitsa. Samples of ore were sent to Moscow for test. Soon afterwards, instructions were received to build a works on the spot. The Nitsynsk works built in 1631 was equipped with bloomeries and manual bellows. This works was the ancestor of the entire metallurgical industry of the Urals. Its exact position is at the present time unknown. It is presumed that it was near the village of Nitsynsk on the river Nitsa.

In 1640, the Pyskorsk copper smelting works was founded on the river Kamgork. It smelted the copper ores of the Kushgorsk and Grigorovsk ore mines. In 1657, however, the mines became exhausted and the works closed down. Its manager Dmitry Tumashev obtained a license to prospect for ores and found iron ore on the river Nevya. There, in 1669, the Fedkovsk works was built and was in full swing until 1680, when began to fall off and soon closed down altogether.

In the middle of the 17th century and up to the second quarter of the 18th century a number of peasant-owned furnaces were in operation in the Urals. They produced blooms which were forged into the simple "sections" of that time – strips, bars and plates. At the end of the 17th century, in the Kungursk district alone there were up to 40 small peasant works, in which were smelted up to 50 poods (about 1800 lbs) per year. One tenth of their production went to the state.

Due to poor communications, Ural iron was dearer than Tulsk or foreign iron. The development of the Ural metallurgical industry therefore proceeded very slowly until the beginning of the 18th century, when the war with the Swedes obliged Russia to put an end to foreign trade. The growing demand for iron for the army and fleet resulted in the development of the Russian metallurgical industry. New metallurgical works appeared at Lipets, Olenets, Sestroretsk and St. Petersburg. The high grade, easily smelted Ural ores began to attract attention.

In 1697, Peter I issued a decree concerning the search for a place in the Urals for the building of a works, and a year later the construction of the Nevyansk works was commenced, and two years later that of a second works on the Kamenka. On December 15, 1701, the first furnace of the Nevyansk works produced pig iron, and on January 8, 1702, the first bloom was obtained. The iron was sent to Moscow to the Arsenal, where it was accepted as suitable. The Kamensk works produced its first pig iron two months earlier than the Nevyansk works; two mortars and three guns were cast from it. In 1702, the Kamensk works had already produced 300 guns.

With the experience of the first two works, others began to be built: the Uktusk copper smelting works and the Alapaevsk iron works. These were government works.

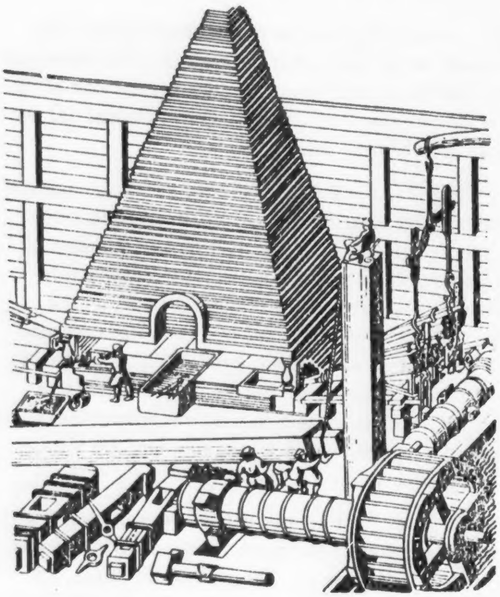


Fig. 2. Bloomery. In the foreground, a bloom hammer is being assembled.

At this time, a Tulsk smithNikita Antufyev petitioned Peter I for a license to cast guns at the Nevyansk works. Peter gave him the licence and then presented him with the works as his own private property, together with the land, woods and peasants attached to the works. Antufyev was obliged to supply the army with the cheapest guns and iron stores. He was subsequently elected to the nobility, and his son Akinfy no longer called himself Antufyev but Demidov, after his uncle. This was the origin of the Demidov line of Ural metallurgical works owners, who subsequently became the Princes San Donato, a line which for many long years drenched the whole of the Urals with the blood and sweat of their serfs. The Demidovs built many works in the Urals, where they pitilessly exploited the labor of their peasant serfs. It is not surprising that at the time of the Pugachev rising the people of the Demidov metallurgical works were in the forefront of the rebels.

In 1722, Georg Wilhelm Hennin was commanded to the Urals with instructions to build works and organize the smelting of copper and silver in the Urals.

Hennin endeavored to find a theoretical basis for the selection of the working area on which to build the works, starting from the local conditions. He strengthened the division of labor at the works and endeavored to calculate the cost of production and determine the economic expenditure and the standards of production.

During this period, the building of private works increased.

In 12 years (1722-1734), 18 works were built in the Urals. In 1734, Hennin was replaced by Tatishchev, who in principle continued the works policy of Hennin.

The successors of Peter I did not consider it necessary to build new state works; it was better to increase the number of private works and receive taxes from them. This was also due to the fact that the cost of metal at the state works was extremely high.

In 1735, two brothers called Chumpin discovered an ore deposit on Mount Blagodat. One of them went

to the Demidovs to tell them of the discovery and the other took a sample of ore to an expert S. Yartsev, who worked nearby. When the latter saw the ore, he dropped his work and galloped off to Ekaterinburg (now Sverdlovsk). As he was riding past the Nevyansky works, Demidov, who did not yet know of the find, tried to hold him, suspecting that there was something the matter; Yartsev, however, escaping from the chase told Tatischev of the discovery. Two hours after lodging the claim, Demidov's steward galloped up with a claim to the same mountain, but was too late. Chumpin received 20 rubles in reward, and the building of two works was commenced at Mount Blagodat, the Kushvinsk and the Turinsk works. Demidov and his brother works owners, the Osokins, still managed, however, to obtain plots on this mountain.

At this time, the Empress Anna Ioannovna was on the throne of Russia. Her favorite, the Kurland Duke Ernest Biron, had long wanted to hand all the works over to private individuals and receive money and iron from them. He appreciated Chumpin's discovery and decided to make use of it, creating a Berg-Direktorium, at the head of which he put the Saxon Schemberg. At the Berg-Direktorium, he set up a "Commission on Mining Matters" which considered the question of the works and decided to hand them over to private individuals. From that date (1736) the works were distributed to favorites and courtiers as gifts and were sold in instalments. Towards the 60's of the 18th century, the only works left to the state were the Kamensk works and the Ekaterinburg works, built by Hennin, with the mint attached to it.

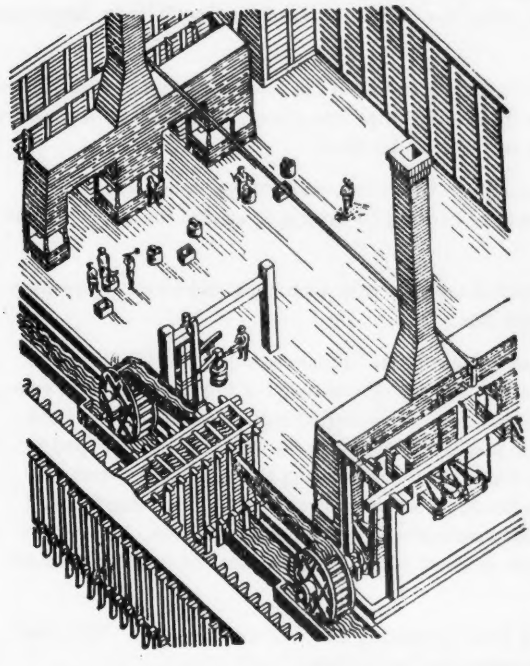


Fig. 3. "Uklad" (crude steel) shop.

At this time, the Demidovs by bribery secured themselves privileges beyond even the dreams of the other works owners. They succeeded in having the state trusteeship removed almost completely from their works, and the other owners were prohibited from working ore in those places where the Demidov mines were situated. In 1720, the Demidovs owned six works, but in 1735-1736 they already had 23 works and in 1750, 34. Most of these works were situated in the Urals. In 1747-1749, Demidov's Ural works produced an average of about 400 thousand poods per year (the state works produced about 300 thousand poods of iron per year). The value of the Demidov's Ural property – works, timber, estate, money and valuables – amounted to about 1 million rubles (at prices prevailing at the end of the 19th century, this sum was equivalent to 25 million rubles).

In 1745, Akinfy Demidov died. His enormous inheritance was divided among his three sons.

Towards the end of the 18th century, the rate of growth of the Demidov works began to decrease. In 1751-1760, the Demidovs built ten works, but from 1781-1800 they built only six. This growth was mainly due to the increase in the Nizhne-Tagilsk group of works, belonging to Demidov's youngest son, Nikita. It suffices to say that towards the end of the 18th century, the works of this group produced 478 thousand poods of iron, not including steel, "uklad" (crude steel) and copper.

This output, which was enormous for the time, placed Russia at the end of the 18th century in the leading position in the world for iron production. An enormous quantity of Russian iron articles were sold abroad, which still further increased the wealth of the capitalists, who pitilessly exploited their serf workers.

Particular attention should be paid to the technology of metallurgical production in the Urals at that time.

As a rule, works were built on the banks of a river, across which was thrown a dam. A waterwheel, set up on the river, utilized the power of the water to supply blast to the furnaces, to work the hammers, etc. The ore as received at the works from the mine was in the calcined state. On arrival, it was carefully checked and

sorted and then put in storehouses. For improving the condition of the iron, several different sorts of ore were blended. The pig obtained from the ore was inspected and made into iron. In addition, the pig iron was tested for fracture. If the fracture was "dark gray and the eye small like a poppy seed" this pig iron was considered to be first grade; fine grained pig, whitish in fracture, was medium grade, while white, coarse-grained pig iron was regarded as suitable only for casting anvils.

The height of the blast furnaces at the Ural works was 9-10 meters. It should be observed that the "most famous" was considered to be a furnace in Sussex in England with a height of 8.5 meters. This furnace produced no more than 1600 kg of pig iron per day, while the Ural furnaces gave 2½ times as much. The charcoal consumption in the Russian furnaces was much less.

Bellows were used for supplying blast to the blast furnaces. Piston blowing engines appeared in the Urals only in 1788.

The pig iron made in the furnaces was used for the manufacture of cast articles or was cast into pigs in special depressions in front of the furnace and these pigs were worked into iron in refinery hearths. In the latter was also charged the simple "metal scrap" of the time: – broken anvils, sheet iron and wire waste. It is interesting that if second quality pig iron was used for refining, as much first quality pig iron was added. The pig iron was charged into the furnaces, heated to a pasty condition and was puddled with bars, so that first one part and then another was exposed to the stream of air which burned the impurities out of the iron. The ball or bloom was then removed from the furnace and forged, the slag being squeezed out by hammering. Even at that time, the Ural iron workers avoided the production of large bloom, since the carbon was not burned out fully in large masses of pig iron and the iron produced was brittle.

The heads of refinery hammers were exchangeable; for squeezing out the blooms, hammers with rounded heads were used; for drawing out rods and strips, and also for beating strips into plates, the hammers had a narrow and flat head; for smoothing out the plates, the hammers had a wide flat head.

After squeezing out the slag, the bloom was heated several times and was then drawn out into rods or strips. Before being sent to the market, the iron was tested for bending by striking it against the anvil. It was then branded and sent to the market.

Small cuttings and broken pieces of iron were collected together with worn tools and scale. They were afterwards remelted in refinery hearths and made into strip iron.

Some of the rod and strip iron was worked up into so-called "uklad" (crude steel) in special factories. The furnaces for making "uklad" resembled refinery hearths. The charge consisted of broken pieces and cuttings of iron and scale, added in a certain proportion "so that the blooms settled more quickly and the juice (slag) was more liquid." These blooms were then cut into pieces and boiled in the furnace, being dipped in the molten pig iron from time to time. They were then drawn out by hammering and quenched. Steel was made from "uklad," the "uklad" was drawn out into thin blocks; these were assembled, welded together and beaten under the hammer, until the joints between the individual blocks were no longer visible. The blocks were then folded and again forged to small sections of rods or sword blades. The beaten out steel was heated and quenched in water.

The "uklad" and steel were tested, like the refined iron, by striking them against the anvil. They had to break but not bend. The metal was then inspected according to the fracture.

In 1798, the first attempt to cement steel in Russia was made at the Ekaterinburg mint. The attempt was successful: Russian cemented steel for striking coins turned out to be better than English steel. At this time, however, there was a change in the head of the mining department and the new head showed no interest in the experiments. Private owners of works, principally Demidov in Nizhne Tagil, began to turn their attention to cementation.

The following are examples of the production at the Ural works in the 18th century.

(1) Cast iron bayonets and various iron castings, shafts for hammer rolls, toothed wheels, slabs, columns, anvils, moulds for casting copper ingots, etc.; (2) guns; (3) bar and strip iron; (4) "uklad" in strips and blocks; (5) steel in strips; (6) sheets, square iron sheets with the dimensions 0.71 × 0.71 meter and 0.53 × 0.53 meter, thickness about 1 mm; sheet iron 0.36 × 0.27 meter and 0.44 × 0.36 meter; (8) various sheet iron vessels – boxes,

jugs, plates, drinking vessels, rasps, etc.; (9) flattened iron strips; (10) tools — miner's hacks, spades, hammers, augers, etc.; (11) anchors.

Thus, in the 18th century, Russia was able to produce all forms of iron products, meet her own requirements in iron to the full and even export manufactured and semi-manufactured iron articles to foreign countries.

Excessive exploitation and obsolete feudal forms of ownership were to, and finally did, reduce the Urals to the condition found in the middle of the 19th century. This alone is sufficient to explain the decline of the Russian metallurgical industry, a decline remedied only after the great socialist October Revolution.

Soviet power, by destroying the exploitation of man by man, has restored the bygone fame of the Ural iron masters, has rebuilt the works on the foundations of modern technology and has secured unprecedented prosperity for the industry.

METALLURGY ABROAD

NEW TYPES OF NUT AND BOLT MAKING MACHINES

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During the post-war years, industrialists in the capitalist countries have built new improved machines for the production of fastening elements, the construction of which has involved the application of recent achievements in science and technology. The present article is a review of the types of new machines for making nuts and bolts, which are now being marketed by foreign firms.

Boltmaking equipment. The method of making bolts of diameters of up to 16-20 mm by upsetting enjoys popularity. This method comprises the following operations: cutting off the blank and heading in a double-blow cold upsetting press, machining the flats of the bolt head with simultaneous reduction of the shank in a trimming press preparatory to thread rolling, followed by thread rolling in a special automatic machine.

Bolts of large diameters are upset hot in friction presses or semi-hot automatic machines. Sometimes the bolt is upset with an auxiliary head equal to the thread diameter. In such a case, the thread is rolled on the shank without reduction.

Cold upsetting equipment does not differ in principle from that marketed some years ago, but has merely undergone some modernization, enabling the capacity of the press to be increased – use of new forms of material, replacement of iron castings by steel castings, slight improvements in the construction of various units and details.

For mechanizing labor-consuming work, the equipment is sometimes assembled in production lines, which occasionally also include the operations of greasing the bolts and packing them in boxes. This considerably increases the productivity of the attendants, and improves the working conditions and the quality of the products.

In spite of all this, however, the machining technology remains the same. The bolt head is upset from the blank in two blows, the blank diameter being equal to the mean thread diameter (when working without reduction) or to the external thread diameter (when working with reduction prior to thread rolling).

The internal stresses set up in these operations at the transition point from shank to head often result in the head being broken off, and this cannot always be avoided, even by annealing the bolts or the original metal.

The first Russian "Boltmaker," combining the operations of heading, machining the flats, reducing the shank and rolling the thread in one machine is constructed on the basis of this old technology; the "Boltmaster" of the Peltzer firm, made in the Federal Republic of Germany (Fig. 1), also normally operates on the same principle, although this machine may operate according to the more improved "Bauer-Schaurte" method described below. The firm does not regard it as profitable for the same machine to roll the thread, since this considerably reduces the flexibility and productivity of the processes (much time is lost in readjusting the press from one size to another). The firm therefore proposes to provide the "Boltmaster" equipment with a thread rolling machine having an automatic device for feeding the blanks from the "Boltmaster."

The tool for all the operations performed by the unit is positioned vertically, thus facilitating mounting, replacement and adjustment. The blank is moved from one die to the next by means of a magnetic holding device.

Considerable interest is afforded by bolt-making equipment operating on a new technical principle: in

the U.S.A. the "Progress Header" and in the Federal Republic of Germany the "Dexbolt" and "Bauer-Schaurte." The bolt is upset from rod (or wire), the diameter of which is larger than the thread diameter. In the first place, the rod is reduced to a diameter equal to the external thread diameter (in doing this, the metal for forming the head remains undeformed); the bolt head is then upset in one blow. At the same time, the rod is again reduced for thread rolling. In this way, the work hardening of the head and its internal stresses are less then by the old method, since upsetting is by one blow. The faces of the head are machined or shaped without loss, and the rod end is chamfered by pressing.

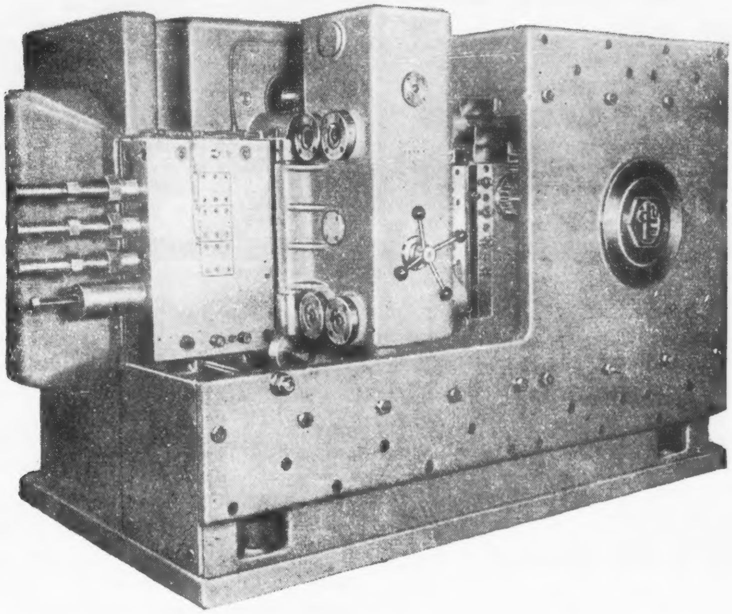

Fig. 1. Multi-position "Boltmaster" press of the Peltzer firm (Federal Republic of Germany).

This operating principle is applied in presses of the Swiss firm of Hatebur (without rolling) and the "Boltmakers" of the American National Machinery Company (Fig. 2), which make bolts with rolled threads.

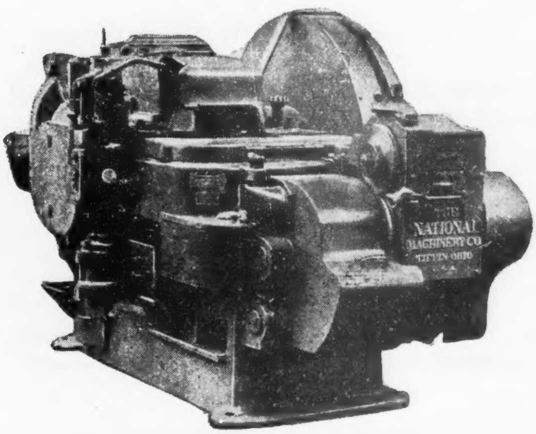

Fig. 2. "Boltmaker" of the National Machinery Company, U.S.A.

Nut-making equipment. Until recently, nuts with a thread diameter of up to 16 mm were cut of cold flat iron. Nuts of larger dimensions are made from hot metal. In this method, the waste is very high (about 80% of the weight of the finished nut).

At the present time, the method of making the nuts by upsetting from round or hexagon bar is gaining in popularity; in this method, the waste does not exceed 20-25% of weight of the nut. Equipment for making nuts by this method is sold in capitalist countries and in the Soviet Union. The process of cold upsetting from round bar is satisfactory for nuts of a thread diameter of up to 16 mm. Presses for nuts of a diameter up to 25 mm have been found to be very bulky and difficult to service.

Steel for nut making must be low carbon, as clean as possible and plastic, with a fine-grain structure requiring laborious heat treatment.

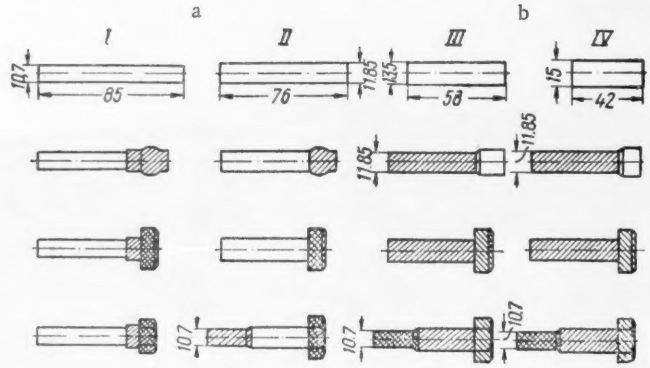

Fig. 3. Diagram illustrating the upsetting of a bolt in a double blow press (a) and in a multiposition press with double reduction (b). I) without reduction; II) with reduction; III) "Dexbolt" process; IV) "Bauer-Schaurte" process.

For working by this method, the Swiss firm of Hatebur makes two types of press.

Presses of the first type are intended for making nuts from hexagonal bar, machining being performed on two units in succession (Figs. 4 and 5); the first cuts the blank off the bar and upsets it, the second finishes the faces of the nut and presses out the center hole. Due to the lateral flow of metal, the height of the pressed-out waste is much less than the height of the nut. According to information received from the firm, the metal waste is thus not more than 12%.

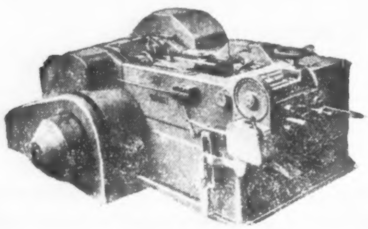

Fig. 4. Press made by the Hatebur firm (Switzerland) for cutting nut blanks from hexagonal bar.

If necessary, after the first pressing, the nuts may be annealed before being fed to the second press for final machining. In this case, the nuts may be made of high-carbon or alloy steel. In finish, they are not inferior to nuts made on automatic lathes.

The second type of press (Fig. 6) is for hot upsetting nuts 16 mm (5/8") or more in diameter from round bar. For upsetting in this press, the bar is not previously heat treated. A press of this type is much smaller than a cold upsetting press and consumes less electric power. The bars are heated by gas or high frequency current.

The firm supplies complete production lines comprising a heating device and press and automatic nut cutting machine.

According to the firm's information, the waste of metal does not exceed 8-12%.

Application of the equipment. In the mass production of bolts of a single type, when there is no requirement for frequent readjustments from one size to another, it is expedient to use bolt "Combines," "Boltmakers" producing finished, threaded bolts.

In the case of small series production, it is preferable to form production lines comprising multiposition presses with double reduction, automatic thread-rolling machines and apparatus for greasing the finished bolts and packing them in boxes.

For executing small orders requiring frequent adjustment of the equipment, modern high-speed double blow presses, automatic stock cutting machines followed by thread-rolling on special units should be used. In this way, it is possible to readjust to a new dimension along the entire line without long stoppages.

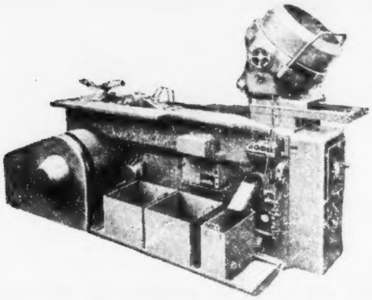

Fig. 5. Hatebur press for upsetting holes prior to threading, and ejecting the punchings.

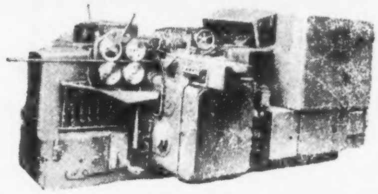

Fig. 6. Hatebur automatic machine AMR-30 for hot upsetting nuts from round stock.

Nuts of low-carbon steel of a thread diameter of up to 16 mm are best made by cold upsetting from round stock, and larger diameters by hot upsetting from rod. If the carbon content of the steel is higher than 0.2%, the nuts may be upset from hexagonal bar.

In all cases, the nut-making equipment should fit into the mechanized production lines along with automatic thread-cutting machines.

When introducing bolt "Combine" – "Boltmakers" and multiposition bolt and nut presses into production, compound tools with hard alloy bits should be used, since the ordinary punches, dies and other tools of carbon and alloy steel wear rapidly, thus cancelling out the advantages of modern high-speed equipment.

COIL DETACHER ON AN EAST GERMAN WIRE MACHINE

P. P. Impatov

Department of the Chief Engineer of the Ministry of Ferrous Metallurgy of the U. S. S. R.

As a rule, modern wire making machines are equipped with hook conveyors for transporting the wire coils from the coiling machines to the finished product store. On most wire making machines of the Soviet Union, the end part of these conveyors is not very highly mechanized.

At some works, the coils are removed from the conveyor hooks by hand, at others they are dumped on the floor of the store and packaged by hand. At some shops, the coils are detached by means of compressed-air hoists or other hoisting means.

Due to the inadequate mechanization of the end section of hook conveyors, much physical labor is required in this section.

At one metallurgical works in the German Democratic Republic, the recently built wire shop uses coil detachers of very successful design. Basically, the entire plant is made of steel construction; reducing gears and electric motors are absent (Fig. 1).

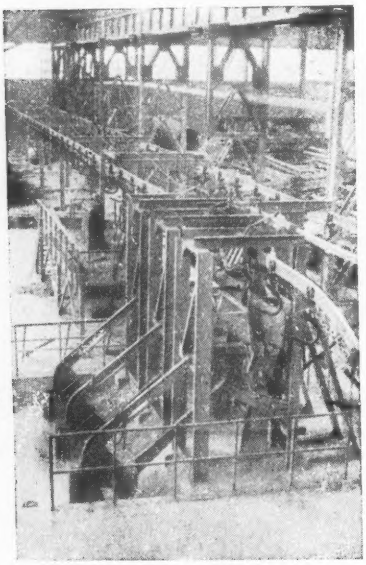

Fig. 1. Hook conveyor.

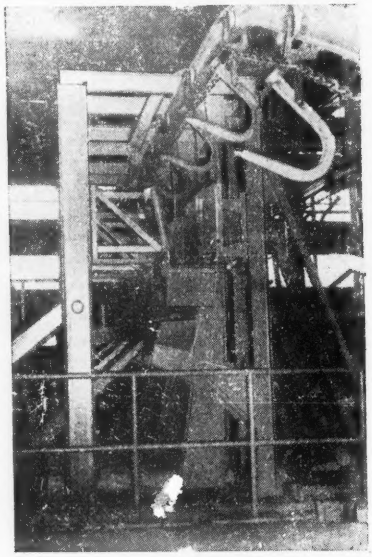

Fig. 2. Coil detacher.

A coil is dumped as follows: The coil is carried by the hook conveyor under the frame of one of three detachers, where by means of checks having an inclined surface it is dumped on to a special transporting bar, holding 12 coils (Fig. 2).

When the first bar is filled with coils, the check of the first detacher is removed and is set up at the second detacher. The coils are now dumped on to a second bar. In the meantime, the full bar of the first detacher has been transferred by overhead crane to the finished product store and unloaded. After the second bar has been filled, the coils are dumped in the third detacher. The cycle is then repeated.

At the above-mentioned works, three detachers are provided for normal working of the wire machine, the capacity of the machine being then 100,000 tons per annum.

NEW BOOKS

Ya. B. FURMAN, Handbook for Section Steel Rollers, Moscow, Metallurgy Press, 1956, 220 pages.

This book embraces rolling technology and rolling mill equipment.

The first chapter gives a general outline of the concept of metallurgical production and the structure of a metallurgical works.

The second chapter discusses the properties of steel and the effect of different impurities on these properties, ingots and their defects and the preparation of ingots and billets for rolling.

The third chapter describes the construction and operation of soaking pits and reheating furnaces. It discusses the fuel for furnaces, technology of heating and incorrect conduct of heating which may affect the quality of the rolled material.

The fourth chapter "Rolling mill equipment" provides information on the classification of rolling stands, equipment and fittings, drive, transporting and accessory mechanisms of rolling mills (transfer devices, manipulators, coilers, etc).

In the fifth chapter, the author sets forth the principles of rolling theory – methods of working metal by pressure, deformation of metal, reduction, elongation and lateral spread of the metal, forward flow and pressure of the metal on the rolls in the rolling process. Some information is also provided on the fundamental phenomena accompanying the cold working of metals by pressure, intermediate annealing and recrystallization.

The sixth chapter discusses the principles of roll pass design and the forms and construction of the passes.

In the seventh chapter "Technology of section-rolled products," the basic technical rolling schemes for section steel are given. Questions of automation of rolling mills, roll-changing and adjustment of roll stands are discussed. The origin of scrap in rolling, the means for combatting it and the organization of technical inspection in rolling mills are dealt with in detail.

The final chapter, the eighth, covers basic knowledge of labor organization and safety measures in section rolling mills.

The book is a textbook for industrial training schools and may be useful for workmen and foremen in rolling mills.

N. I. SHEFTEL. Drawn and Cold-Rolled Steel, Moscow, Metallurgy Press, 1956 249 pages.

The book generalizes working experience of cold-rolling drawing shops.

The first part describes the technical process of rod drawing – from the preparation of the rolled material for drawing to pickling of the finished rods. This part also discusses the different types of rod-drawing machines. In 46 tables data are given regarding the various technical factors involved in drawing and the experiments of investigators studying the problems of drawn steel production. The straightening and heat-treatment of rods is discussed and the experience of a number of works making drawn steel is set forth.

The second part describes the production of cold-rolled steel. A description is given of rolls for cold rolling steel, their profiling and the working temperature conditions. Information is given regarding the construction of cold rolling mills for steel, their productivity and the technology of rolling. Separate sections are devoted to the rolling of stainless steel, nickel-aluminum steel and transformer steel. Reference is made to the technology of dressing cold-rolled steel.

N. I. Sheftel's book is intended for engineer-technical workers of cold-rolling mills and scientific research institutes.

EXHIBITION OF WORK BY ARTIST-METALLURGISTS

The studio of pictorial art at the metallurgists club of the "Zaporozhstal" works has now been in existence for six years. Steel melters, furnacemen, engineers and even members of workers' families devote themselves to study in it.

Mechanic S. Tkachenko working at a sculptural composition "Ordzhonikidze at the Zaparozhstal works"

Classes are held in it on the theory and history of the pictorial art. Every year the studio brings its creative work to the notice of the works community and holds exhibitions of its artistic works.

The last works exhibition of amateur artists, dedicated to the World Festival of Youth and Students was organized in December, 1956. More than 300 works were shown at it.

Well-deserved success was enjoyed by member of the Young Communist League steel melter K. Efimchuk "Steel being teemed." Engineer of the open-hearth steel plant Yu. P. Satanovsky exhibited 30 studies including views of the "Zaporozhstal" works and the surrounding of Zaporozhe.

Workman of the Gorky Club Comrade Shinkarenko painted the portrait of a furnaceman. This work has been sent to the Republic Exhibition. Technical Inspector M. Shvartsberg, in his works, especially in the picture "We need peace" illustrated the struggle of the Soviet people for peace. He also painted portraits of the best people of the works – production innovators S. M. Martynov, A. N. Nebylitsyn, S. S. Yakimenko and others.

The first prize was awarded to V. Protoirenko for his picture "Oak Plantation" and a portrait of steel melter Litvinenko. A young artist-rolling mill operator V. Vlasenko gained a prize for his picture "I shall be a metallurgist." Comrades Satanovsky, Shvartsberg and many others gained prizes.

The members of the sculpture circle of the metallurgists club took part in the exhibition. Considerable success was enjoyed by the sculpture composition "Ordzhonikidze at the Zaparozhstal works," executed by workshop mechanic S. Tkachenko.

Work was also exhibited by S. Ermakov "No better off than at the start" (from the tale by Pushkin), and by lathe machinist M. Belokonov "The student." All these sculptures have been sent to the Republic Exhibition.

Machine shop mechanic V. Orlenets received a prize for his beautiful photographs of Zaporozhe and Moscow. More than 20 of his photographs have also been sent to the Republic Exhibition.

Over 20,000 people visited the exhibition of works by our amateur artists.

At the present time, the studio is actively preparing an exhibition in honor of the 40th anniversary of the October revolution. Engineer Yu. P. Satanovsky is painting a series of views of our works.

V. Protoirenko is working on a picture "The prospectors," M. Shvartsberg on a composition "On the eve of the revolution" and S. Tkachenko is making a sculpture of Lenin. Members of the studio are painting portraits of men who took part in the October revolution.

I. Menshikov
President of the Management Committee of the
Metallurgists Club of the "Zaparozhstal" Works

METALLURGIST IN ENGLISH TRANSLATION

June, 1957

TABLE OF CONTENTS

	Page	Russ. Page
1. New Techniques for Metallurgists	353	1
2. The Use of Natural Gas in Ferrous Metallurgy. A. Ya. Lenkov	354	2
Blast-Furnace Production		
3. Operation of Blast Furnaces on Oxygen-Enriched Blast. F. A. Khilkevich, B. L. Lazarev and S. V. Bazilevich	356	3
4. Complex Automation of Hot-Blast Stoves at the Kuznetsk Metallurgical Combine	361	8
5. All-Union Conference of Blast-Furnace Men and Sinter Plant Operators	366	11
6. Deoxidation of Rimming Steel by Ferromanganese in the Ladle. D. S. Gerchikov, A. M. Ofengenden, and L. M. Pokrass	368	13
7. The Effect of Oxygen on the Quality of Mild Rimmed Steel. A. M. Pochtman	372	15
Steel-Melting Production		
8. Application of Sinter in Open-Hearth Melting. N. A. Vecher, A. A. Lebedev and N. D. Korneev	374	17
9. Thin-Walled Ingot Moulds for Casting Killed Steel. A. M. Danilov	377	19
10. Fettling the Bottom and Sides of Electric Furnaces with Fine Chrome Ore. V. Ya. Monastyrsky and A. N. Glazov	379	21
Rolled Material and Tube Production		
11. Increasing the Productivity of a Sheet Mill. A. A. Nefedov and G. Z. Shcherbina	381	23
12. Selection of a Rational Pneumatic Steel-Dressing Tool. N. V. Amchislavsky, R. A. Braunshtein and M. S. Shlionsky	384	25
Production of Rolled Material and Tubes		
13. Reducing the Consumption of Blooming Mill Rolls. N. V. Slizen	388	29
14. Conference on Build-Up Welding of Parts of Metallurgical Equipment. V. K. Petrichenko	389	30
15. Letter to the Editor	393	32
Hardware Production		
16. Continuous Automatic Production Lines for Wood-Screw Manufacture. S. A. Morozov	395	33
Experience of Innovators		
17. Working Methods of Flame Cutter Operators E. F. Abrosimov and D. P. Semikhatov. V. A. Galkov	397	35

(continued)

TABLE OF CONTENTS (continued)

		Page	Russ. Page
18.	New Books	400	36
19.	Organization of the Repair Service in Metallurgical Works. A. I. Gurvits	402	37
	New Developments in Sciences and Technology		
20.	Cybernetics and Metallurgy. Yu. A. Shreider	404	38
	Outstanding Metallurgists		
21.	Academician N. P. Chizhevsky, D. V. Nagorsky	407	40
	From the History of Technology		
22.	From the Past of the Ural Metallurgical Industry	411	42
	Metallurgy Abroad		
23.	New Types of Nut and Bolt Making Machines. V. A. Smirnov	416	45
24.	Coil Detacher on an East German Wire Machine. P. P. Impatov	420	47
	New Books		
25.	Ya. B. Furman, Handbook for Section Steel Rollers	422	48
26.	Exhibition of Work by Artist-Metallurgists. I. Menshikov	424	Inside back cover